NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

THESIS

AN ANALYSIS OF THE EFFECTS OF MILITARY HOUSING ALLOWANCES AND OTHER MILITARY RELATED FACTORS ON PRIVATE SECTOR RENTAL HOUSING PRICES

by

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December, 1996

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE December, 1996	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE AN ANALYSIS OF THE EFFECTS OF MILITARY HOUSING ALLOWANCES AND OTHER MILITARY RELATED FACTORS ON PRIVATE SECTOR RENTAL HOUSING PRICES

5. FUNDING NUMBERS

6. AUTHOR(S) Gary L. Wick

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Facilities Engineering Command, Alexandria, VA

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

Privatization of Military Family Housing will place a greater reliance on private sector rental housing. Before the DoD embarks on any policy changes that place a greater emphasis on private sector housing, the DoD must be certain that rental property landlords do not raise rental prices based on changes in a service member's housing allowances. This thesis explores the relationship between changes in military housing allowances and changes in private sector rental prices. A multiple regression model was used to determine this correlation. Department of Housing and Urban Development (HUD) Fair Market Rent data was used to measure the changes in private sector rent prices in 25 cities. Basic Allowance for Quarters (BAQ), Variable Housing Allowance (VHA) rates, and a ratio that measured the presence of military members in a given area were used as the independent variables. Using the three independent variables described above, the result did confirm the popular impression that rent prices do rise with increases in housing allowances. However, the correlation was not as significant as anticipated. In an effort to make the model more useful as a policy tool, recommendations are provided for an expanded dependent variable data source and additional independent variables.

14. SUBJECT TERMS Family Housing, Privatization, Military Housing Allowances.			15. NUMBER OF PAGES 87
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

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Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
December 1996

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ABSTRACT

Privatization of Military Family housing will place a greater reliance on private sector rental housing. Before the DoD embarks on any policy changes that place a greater emphasis on private sector housing, the DoD must be certain that rental property landlords do not raise rental prices based on changes in a service member's housing allowances. This thesis explores the relationship between changes in military housing allowances and changes in private sector rental prices. A multiple regression model was used to determine this correlation. Department of Housing and Urban Development (HUD) Fair Market Rent data was used to measure the changes in private sector rent prices in 25 cities. Basic Allowance for Quarters (BAQ), Variable Housing Allowance (VHA) rates, and a ratio that measured the presence of military members in a given area were used as independent variables. Using the three independent variables described above, the result did confirm the popular impression that rent prices do rise with increases in housing allowances. However, the correlation was not as significant as anticipated. In an effort to make the model more useful as a policy tool, recommendations are provided for an expanded dependent variable data source and additional independent variables.

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I. INTRODUCTION

A. GENERAL

With the ever increasing stranglehold of federal entitlements (Social Security, Medicare, Medicaid, and Federal Retirement Programs) on the federal budget, the portion of the budget allocated to discretionary spending shrinks every fiscal year. As a major component of the discretionary budget, the Department of Defense (DoD) has been severely impacted by these decreases. With budgets tighter than ever, Pentagon budget officials are looking at a variety of alternatives to reduce the DoD's operating costs.

When one thinks of cuts in the military, typically, one envisions fewer aircraft carriers, fewer tactical air wings, or fewer ground combat assets. Often overlooked are cuts in the military family housing program. The military housing program is by no means an insignificant portion of the budget. Approximately 7 billion dollars are spent annually by DoD to pay for maintaining its military housing base and in payments of allowances for those who live off base [Ref. 1: p. xi].

Currently, 33 percent of military families live in military housing. It is projected by 1999 that approximately 38 percent of military families will live in on-base housing. To proponents of military readiness, this trend is very encouraging. By housing a larger force on our nation's military installations, it is argued, our overall military readiness is increased. The Congressional Budget Office (CBO) disputes the validity of this argument. CBO argues that only two to five percent of all military personnel are indeed 'key and essential' and are required to live on base [Ref. 1:p. 12]. Of greater concern to CBO and other officials is the high cost of housing military members on military installations.

When military members live in family housing, they simply forgo their housing allowances. The amount of these forgone allowances does not come close to covering the actual expenses incurred by the government in providing these quarters. CBO studies suggest that on average, it costs $12,500 per year to operate one military housing unit. On the other hand, an average of $7,500 is paid out in allowances to those who live in the private sector [Ref. 1: p. 18]. This argument will be further analyzed in a later chapter. Based on the numbers alone, it costs the DoD roughly $5,000 more per year per family to provide family housing vice having the family live in the private sector.

The DoD is currently at a crossroads. What is the most efficient manner to house its service members? Cost alone is not the only variable to be considered. Quality of housing, convenience, and location of housing are just a few of the variables that must be addressed. Realistically, the DoD has three options: (1) maintain the status quo, (2) revitalize existing housing and maintain the current allowance system, or (3) completely divest itself of its housing inventory and pay all members allowances for quarters. The pros and cons of these three options will be discussed along with other policy considerations in Chapter III.

B. EMPHASIS OF RESEARCH

In order to solve its current housing dilemma, DoD is aggressively investigating options that place a greater reliance on the private sector. There is a widespread belief in the DoD that, once the BAQ and VHA rates are announced for the year, landlords automatically raise their rents to military members to match these increases. With a possible move toward privatization in the future, now is the time to determine whether a direct correlation indeed exists between increases in military housing allowance amounts and increases in private sector rental amounts. This thesis will concentrate on whether this correlation actually exists. If in fact our service members are victims of "rent gouging" by the overall rental population, the DoD needs to be

made aware of this problem before it institutes a new system that will place a greater reliance on the private sector.

C. THE BASIS FOR PRIVATIZATION

Privatization is not a new concept in the DoD. The August 1983 Office of Management and Budget's Circular A-76: Performance of Commercial Activities, encourages privatization, outsourcing, and competition with the goal of decreased costs to the government and improved performance. To date, the DoD has already reaped the benefits of outsourcing in such diverse areas as health services, equipment maintenance, data processing, and other nonmanufacturing operations, to name a few. Specifically, the Naval Facilities Engineering Command (NAVFAC) has extensive experience in outsourcing through its commercialization of numerous base maintenance functions. This experience makes NAVFAC the natural choice as the leader in investigating the feasibility of privatizing military housing.

1. Past Attempts at Privatization

As a result of the Military Construction Authorization Act of 1984, two third-party financing authorities for family housing were created. The first of these, Section 801 (Title Code 10 U.S. Code, section 2836) was essentially a lease-build program. Under Section 801, the Services signed a 20 year lease/purchase with a private developer who built homes to military specification on government or privately owned land. Service members were assigned to these homes just like they would be assigned to existing government quarters. Residents forfeited their housing allowances to live in these homes. Once the initial implementation problems were solved, the Services and the private sector became very interested in Section 801 Housing. In fact, 11,100 homes were built for the Department of Defense between the years 1985 and 1995.

Adopting a slighly different approach, Section 802 was a rental guarantee program for developers. Based on a 25 year agreement, the Services guaranteed private developers a 97

percent occupancy rate. If the occupancy rate of service members fell below the 97 percent threshold, the services would subsidize the developer. The rental rate would be based on the amount of their Basic Allowance for Quarters (BAQ) and their Variable Housing Allowance (VHA). Additionally, military personnel had priority over civilian renters. Since BAQ and VHA are only designed to cover 80 percent of a member's housing expenses, very little interest developed in the program. To date, only one project has been successfully completed- 276 units at Marine Corps Air Station Kaneohe Bay, Hawaii. Section 802 failed primarily because developers felt that the high inherent risks outweighed the financial incentives.

A third attempt at privatization, real estate outleasing (Section 2667) is another method used by DoD to entice private developers. This program provides non-excess government land that can be leased by developers. The developers build housing on the land with leases of up to 99 years. House rents are based on BAQ plus VHA for the first year and are adjusted for inflation in the following years. Service members enter into individual leases and pay their housing allowance directly to the developer. Unlike Section 802 program, there are no occupancy guarantees. To date, only 220 units of Section 2667 housing have been completed at Fort Ord, California.

The aforementioned initiatives were designed to acquire military family housing without having to go through the lengthy, capital intensive Military Construction program. By enticing private contractors with various incentives, it was hoped that homes could be built quicker and cheaper. Unfortunately, the Budget Enforcement Act of 1990 changed the rules for "scoring" and put a damper on these initiatives. Scoring is an accounting term that describes how a financial obligation is accounted for in the federal unified budget. Under the new rules, the total estimated life time cost of the lease must be "scored" in the year in which the obligation is entered. As an example, a housing project is estimated to cost 25 million dollars to build and 1

million dollars per year to maintain for its 40 year expected life. Per the current budget scoring rules, DoD must record a liability of 65 million dollars the year it is constructed. Under the old rules, a liability of only 25 million would have been recorded. This accounting change basically crippled the Section 801 and 802 initiatives because of the pay-as-you-go (PAYGO) stipulations in the Budget Enforcement Act of 1990.

2. Current Attempts at Privatization

In an attempt to resuscitate interest in housing privatization, Secretary of Defense Perry established the Housing Revitalization Support Office (HRSO) on 25 September 1995. With a staff of approximately 40, HRSO is set up like a private sector consulting firm with expertise in the following areas: housing, real estate, economics, contracting, engineering, law, and congressional policies and practices. The mission of HRSO is to solve the DoD's current housing shortage by avoiding MILCON and maximizing private sector investment. Some of the initiatives HRSO is investigating will be discussed in greater detail in Chapter III.

II. THE HISTORY OF FAMILY HOUSING AND HOUSING ALLOWANCES

A. GENERAL

The history of military family housing is as fascinating as the history of the housing allowance system. The first part of this chapter is devoted to the history of family housing in the military and the second, to the evolution of the housing allowance system. To fully understand the allowance system, one must understand the key components that comprise it. The remaining sections of this chapter analyze the components and terminology of the allowance system.

B. THE HISTORY OF MILITARY HOUSING

The first attempt at military housing was conducted by the Army when Congress in 1782 authorized the Army to furnish one covered four-horse wagon and one two-horse wagon to a Major General [Ref. 2: p. 59]. After the turn of the 19th century, the base usually provided quarters for the commanding officer and other senior officers. The other officers were usually afforded the opportunity to occupy suitable quarters from the base quartermaster for no fee. During this period, enlisted personnel were considered to be "single". Consequently, they were forced to live in tents, aboard ships, forts, or barracks. Occasionally, enlisted men were allowed to marry. Unfortunately, they were not provided quarters and had to secure them on their own.

By the end of the 1880s, many of the smaller western outposts were closed and consolidated into larger posts. This consolidation presented the opportunity for the Army to improve the quality of quarters for its troops. In 1890, the U.S. Army Quartermaster Department developed a set of standardized facility plans that included improvements in family housing. Early in the 20th century, Congress authorized the military housing construction program (MILCON). By 1939, approximately 25,000 units of housing existed in the Armed Forces [Ref.

2: p. 61]. At the time, this represented a quantity sufficient to house less than ten percent of the troops.

The onset of World War II increased the need for additional military housing. Most of this housing was of either a rental or temporary nature authorized by the Lantham Act. In 1949, the Congress authorized the Wherry Program. The Wherry Program authorized the construction of privately financed housing developments on military installations or on government-owned land. Between the years of 1949 and 1954, the Wherry Program accounted for more than 83,000 new homes.

The year 1950 was a landmark year for military family housing. President Harry S. Truman established the Defense Housing Commission to investigate the problems associated with the housing of military families. An important result of this commission was the creation of the Armed Forces Housing Agency . Although its life was brief (three years) it laid the groundwork for the Defense Housing Bill of 1954. This bill was the first significant Housing Construction appropriations bill, and 18,000 homes were built as a result.

Although the Wherry Program was a step in the right direction, it wasn't without its shortcomings eg. size of units, amenities, etc.. To overcome these problems, Congress authorized the Capehart Program in 1955. Like the Wherry Program, the Capehart Program was to provide government-owned land for housing development by private contractors. The housing projects were awarded through competitive bidding and financed through the proceeds of 100 percent mortgages insured by the Federal Housing Administration. Once the houses were completed, capital stock in the mortgage corporation was delivered to the cognizant service. As a result, the military assumed the mortgages. To pay off these debts, the residents of these homes forfeited their BAQ. To give an idea of the magnitude of this program, 115,000 quality homes were built before the program ended in 1962 [Ref. 2: p. 61]. Developers who

participated in the earlier Wherry Program were concerned with the success of the Capehart Program. They feared the demand for the superior Capehart units would reduce the demand for the older Wherry units. This concern forced the Government to acquire all Wherry homes on or near military installations.

During the 1950s, the military housing inventory expanded to approximately 300,000 units. At the same time, the percentage of married personnel rose form 35 to 45 percent. To address the changing needs of family housing, Secretary of Defense Robert S. McNamara centralized the administration and funding of family housing in the Office of the Secretary of Defense in 1962. A proponent of family housing, McNamara advocated MILCON over private sector financing and also supported an increase in BAQ.

Secretary McNamara's family housing plans were overcome by funding diversions to support the efforts in Viet Nam. Even though a vast percentage of the defense budgets of the mid 1960s and early 1970s were spent on operations in Viet Nam, approximately 8,000 new homes were built per year during this period. However, by the end of the 1970s, construction had dwindled to roughly 1,000 units per year. In 1982, DoD decided to transfer housing management and funding responsibilities back to the services. To ensure funds earmarked for housing were spent for housing, Congress stipulated that housing operations and maintenance funds would be "fenced". Currently, the DoD operates approximately 387,000 government-owned homes.

C. TO WHOM IS MILITARY HOUSING PROVIDED?

The DoD operates approximately 387,000 units of family housing at an annual budget of $4.3 billion. By providing on-base housing to its members, the DoD hopes to (1) improve operational readiness, (2) provide a sense of community for its members, (3) provide safety and security for its tenants, and (4) increase member retention by providing quality modern housing.

Family housing is only available to married service members. Single service members are not eligible for family housing and must either live in the Bachelor Enlisted Quarters (BEQs) or Bachelor Officer Quarters (BOQs) if available, or live on the economy. Currently, there is a shortage of military family housing for the junior enlisted (E-1 through E-3) ranks.

D. THE HISTORY OF HOUSING ALLOWANCES

As a normal practice, Military officers have always been furnished quarters free of charge. When quarters were not available, officers received payments to cover off base expenses. "The Army and Navy Appropriations Act of 1871 specifically prohibited additional allowances for housing. However, it did permit quarters to be furnished-in-kind, thus creating an inequity between living on and off-base. [Ref. 2: p. 59] This "inequity" between those living in quarters and those living off-base will be discussed in greater detail in Chapter III.

Up until 1918, one's marital status had no effect on the amount of one's allowances. In the early 1920's, Congress realized that something had to be done about the existing Housing Allowance system. Congress created a rental allowance for commutation for quarters, heat, and light. This payment was based on the national monthly average for the cost to rent one room. To accomodate married officers, a larger allowance was paid based on the greater amount of rooms needed to house one's family. The rental allowance program was replaced by the Career Compensation Act of 1949. A key element of the Act was the creation of the Basic Allowance for Quarters (BAQ).

In regards to the housing of enlisted personnel, this history is markedly different from that of the officer community. Typically, enlisted personnel have been furnished living accomodations or a cash substitute if quarters were unavailable. It wasn't until 1940 that entitlements were authorized for enlisted members with dependents, and only for the three most

senior enlisted ranks. The Career Compensation Act of 1949 authorized entitlements for all enlisted ranks.

In response to the buildup of forces for the Korean War, Congress passed the War Dependents Assistance Act of 1950. The act established the "Class Q" dependent allotment for all personnel. To improve the allowances for enlisted personnel, the Appropriations Act of 1962 permanently increased the Basic Allowance for Quarters for E-4 through E-9 personnel. Since the Class Q allotment was not part of BAQ, the act was terminated in 1971.

At the end of the Viet Nam War in 1973, the all volunteer force was created along with a change in military culture. In order to retain an all volunteer force, the allowance system had to be improved to mirror the actual costs being incurred by service members. It wasn't until the 1977 Defense Authorization Act that the President was allowed to allocate future pay increases in the areas of Base Pay, BAQ, and the Basic Allowance for Subsistence (BAS) on an other than equal percentage basis. This measure allowed the Congress and the President to make greater changes to Base Pay and BAQ. By making larger increases to Base Pay and BAQ, the intent was to make the service members's compensation closer to that in the civilian sector.

After some interesting fluctuations in compensation increases, Congress scrapped the existing adjustment methods and came up with a new plan in 1985, creating the Variable Housing Allowance (VHA). The Variable Housing Allowance was created to defray housing expenses in high cost areas. The specifics and methods used to calculate the Variable Housing Allowance will be discussed later in section 2.E.5.

For one to fully understand the existing allowance system, a few key terms will be discussed.

E. DISCUSSION OF ALLOWANCE TERMINOLOGY

1. Military Housing Areas (MHAs)

The nation is divided into approximately 320 Military Housing Areas (MHAs). A military housing area, or MHA, is the geographic area that encompasses all public and private housing within 30 miles, or within a 60 minute commute, of a military installation. It is the mission of the Per Diem, Travel and Transportation Allowance Committee (PDTATAC) to calculate the VHA rate for every rank at every MHA and County Cost Group (CCG) (see next sub-section). At a minimum, PDTATAC requires 30 renter responses for an area to qualify as a Military Housing Area.

2. County Cost Groups (CCGs)

For areas with less than 30 responses to the annual VHA survey, the concept of the County Cost Groups (CCGs) is employed. The data from the surveys are compared to local housing costs and the Department of Housing and Urban Development (HUD) Fair Market Rent Data. At the present time, only 2 percent of the eligible service members fall into one of the 40 CCGs considered by PDTATAC.

3. Basic Allowance for Quarters (BAQ)

All service members who live off base qualify for the Basic Allowance for Quarters (BAQ). The amount of the entitlement is based on the service member's rank and marital status. In no way does an individual's housing costs factor into the calculation of his or her entitlement. The amount of this entitlement is adjusted annually in the Defense Authorizaton Bill. For any given rank, a member with dependents will receive a greater BAQ than a single member. To help service members living in government quarters defray incidental living expenses, a BAQ Partial exists. However, this BAQ partial is insignificant in amount (less than 5 percent of full BAQ) and will not be discussed again in this thesis.

4. Variable Housing Allowance (VHA)

The Variable Housing Allowance (VHA) was first authorized in 1985 and is codified under Title 37 USC Section 403a. VHA is a housing entitlement for all uniformed service members who do not reside in government quarters. It was designed to supplement BAQ by defraying housing costs for service members in high cost housing areas in the U.S.. VHA is calculated by PDTATAC for each paygrade at every Military Housing Area (MHA).

The calculation of VHA is rather straightforward and requires only the knowledge of the National Median Cost of Housing (NMCH) and the Local Median Cost of Housing (LMCH) for the paygrade in question. VHA is defined by the following mathematical expression:

$$VHA = LMCH - 0.80NMCH$$

Based on data obtained from the Annual VHA Survey, PDTATAC calculates NMCH for each paygrade. At the same time, they calculate a LMCH for each paygrade at each MHA. In the case of low cost MHAs where the LMCH is less than 80 percent of the NMCH, the member's VHA equals zero, not a negative amount as the expression would suggest.

5. VHA Survey

Each year in March, PDTATAC sends out the annual VHA survey to all service members who do not reside in government quarters. "On average, 60-70 percent of those who receive surveys respond [Ref. 3] The data collected in March is used to calculate the new VHA rates for the following calendar year. Based on the fact the data is used nine months later, the new VHA rate suffers from a recognition lag. With members reporting their own housing expenses, there also exists a concern about accurate data. These limitations will be further discussed in Chapter III.

6. Out-of-Pocket Expense (OOP)

By adding the member's BAQ and VHA, one arrives at the Total Housing Allowance (THA). The THA is an important value that is used to calculate another important value, the Absorption Cost or, as it is commonly referred to, the Out-of-Pocket Expense (OOP).

OOP = LMCH - THA

In theory, one's housing expenses are supposed to equal BAQ + VHA + OOP. This brings up a very critical point. The objective of VHA is to equalize the median out-of-pocket expenses for all service members of a given rank. Unfortunately, the amount of OOP for service members has risen over the last fifteen years (FY81 = 10.4% and FY96 = 20.4%). As Figure 1 depicts, this increase has not been gradual.

Data provided by PDTATAC Brief of 1996

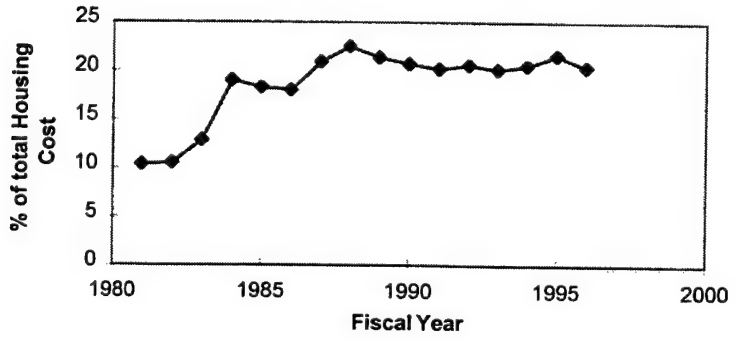


Figure 1: OOP as a Percentage of Total Housing Costs

7. Rental Equivalency

Homeowners account for appproximately 39 percent of the data analyzed in the annual VHA Summary. However, these homeowners'mortgage payments are not used in the

calculation of VHA entitlements. Mortgage payments are usually comprised of the following components (1) principal, (2) interest on principal, (3) property taxes, and (4) insurance. A typical renter does not directly pay property taxes and will probably have a renter's policy instead of a homeowner's insurance policy. Typically, the premium on a renter's policy is less than the premium on a homeowner's policy. These differences tend to skew the actual value of the housing payment. Other reasons mortgage payments are not used in calculating VHA rates are the investment and tax advantages of home ownership.

So how do military homeowners affect the calculations of VHA rates for a given location or paygrade? The homeowner's house size and type are compared to similar rental houses in the area. The rent for these similar properties are used in the actual VHA calculation. The Bureau of Labor Statistics uses the same basic methodology when it calculates the housing component of the Consumer Price Index (CPI).

8. Maximum Allowable Housing Cost (MAHC)

A term often used in housing circles is the Maximum Allowable Housing Cost (MAHC). The MAHC is defined as the sum of 1.5 times one's BAQ plus one's VHA. When one's housing expense exceeds the MAHC, this member is deemed to be unsuitably housed. This concept ignores the fact that a member's spouse might work or other economic considerations. Chapter III will explore the concept and limitations of MAHC in greater detail.

III. POLICY CONSIDERATIONS

As alluded to in Chapter I, the DoD has three options to solve its current problem of a housing shortage. In addition to the discussion of the three proposed options, this chapter will also discuss the issues of Maximum Allowable Housing Cost (MAHC) and a phenomenon that affects high and low cost housing markets.

In summary, Scenario One would retain the existing inventory of government owned housing and cash allowances for those eligible members that live off-base. A combination of existing assets, revitalization of older units, and cash allowances for the remaining members will be discussed in Scenario Two. In addition to revitalization, privatization will be also considered in Scenario Two. By far the most radical of the three scenarios, Scenario Three will explore the feasibility of a complete divestiture of current housing assets by DoD. As a result of this option, housing allowances would be paid to all eligible members. Since the future of family housing will probably rely heavily on private sector housing, it is imperative to understand the correlation between the increases in housing allowances and increases in rental prices.

A. SCENARIO ONE: STATUS QUO

By far, the easiest solution is to maintain the status quo. To assess this option, let us first consider the advantages of maintaining the existing housing system. What makes family housing so attractive to so many service members? In other words, why do so many installations have waiting lists? Stability for members is often touted as a major advantage of the existing family housing system. Service members are accustomed to the manner in which family housing operates. This familiarity aids in their frequent transition to their new assignments around the world.

By creating family housing neighborhoods, a strong sense of community is formed in the military. Based on the constant moves and deployments members of the armed services face, surrounding them with people who face similar challenges helps create a solid, stable neighborhood environment for our service members.

Family housing can be viewed as a "safety net" for new arrivals to a command. When a member receives his or her Permanent Change of Station (PCS) Orders, he or she simply contacts the housing office at the new activity and, if housing is available, it will be pre-arranged. This service is particularly useful to junior service members and members who are transferring from overseas locations.

In the vast majority of cases, the location of military housing is very convenient for service members. Most bases have exchanges, commissaries, day care centers, community centers, and a host of other amenities on base in close proximity to family housing developments. This convenience factor makes family housing very attractive to many service members.

One of the strongest selling points of family housing is the financial incentives it provides members. To live in family housing, the service member simply forgoes his or her BAQ and VHA. As discussed in Chapter II, BAQ and VHA are only designed to cover 80 percent of one's housing expenses. The remaining 20 percent is to be covered in the form of out-of-pocket expenses (OOP). In other words, the member who resides in government quarters is essentially receiving a bonus roughly equal to 20 percent of his or her housing market value. Furthermore, all maintenance and repair in government quarters are provided by the base public works structure. In the case of the home owner in the private sector, any repairs or maintenance costs come out of his or her pocket. By not paying utilities expenses, there is no incentive for the service member to conserve water, heat, or electricity. According to CBO, utility costs currently

account for 30 percent of DoD Family Housing operating and maintenance (O&M) expenses [Ref. 1: p. 23]. This is another example of an economic advantage of living in government quarters.

Although this scenario possesses some strong arguments in favor of maintaining the existing system, further analysis indicates that the status quo will in fact end up costing more and probably accomplish little in reducing the current housing shortage. Based on the September 1993 Congressional Budget Office Report, "Military Family Housing in the United States", the CBO predicts an increased reliance on family housing. Currently 33 percent of the military families live in family housing. Based on their estimates, they predict an increase to 38 percent by the year 1999 [Ref. 1: p. 7]. This statistic is particularly disturbing because the CBO estimates that the DoD pays $5,000 more per year per family housing unit than it provides the average member in housing allowances. With the goal being cost reduction, this is definitely a step in the wrong direction.

Compared to their private sector counterparts, military housing units are more expensive to operate and maintain. "In fact, CBO estimates that compared to similar units in the private sector, military housing units cost on average 35 percent more to operate." (CBO Report, executive summary). By eliminating current units of housing and placing a greater reliance on the private sector, DoD could translate these maintenance and operating expenses into direct savings.

The management of DoD Family housing requires a large management team. Each service has an office fully staffed and dedicated to its own housing mission. Through privatization or some other method that places greater reliance on the private sector, the composition of these staffs and associated overhead will be impacted. We will probably see a shifting of personnel to the area of housing referral vice the current emphasis on maintenance,

operations, quality of life, etc. Naturally, this will probably result in the downsizing of these staffs.

As mentioned in a previous paragraph, utilities usage in housing is a major concern. When the occupant does not pay directly for his or her utilities, there is little incentive to conserve.

One of the biggest challenges facing the current system is the MILCON system. The MILCON process is a lengthy one. For DoD units, up to 10 years may be needed for the process of market analysis, budget planning, Congressional authorization, bid preparation, bid selection, construction, and acceptance of the completed units [Ref. 1: p. 21]. Compared to private developers, this is an inordinate amount of time.

Besides the additional time requirements, the costs associated with labor need to be considered. All DoD construction projects fall under the Davis-Bacon Act of 1931 (40 U.S. Code 276a-1-5). Davis-Bacon requires that all federal construction projects pay "prevailing wage rates". Over time, prevailing wage rates have been interpreted to mean "union wage rates." In localities which do not have a strong union presence, this means higher labor costs than would otherwise be expected. According to some estimates, the Davis-Bacon Act increases DoD's construction costs by between 5 percent and 15 percent compared with the private sector [Ref. 1: p. 21]. However, some argue that these costs can be offset by the economies of scale the contractor takes advantage of when building projects the magnitude of typical MILCON projects.

In summary, the current system places great emphasis on quality of life issues. Unfortunately, from a fiscal perspective, it is not very cost effective. In today's fiscally austere environment, quality of life issues will have to be weighed against programs that can directly result in savings to DoD.

B. SCENARIO TWO: GREATER RELIANCE ON PRIVATIZATION AND REVITALIZATION

Privatization in Family Housing is not a new concept. As noted in Chapter II, previous attempts failed for one of two reasons: (1) the initiative lacked sufficient financial incentives to induce contractors, or (2) legislation such as the Budget Enforcement Act of 1990 made privatization fiscally impractical.

To overcome the second challenge mentioned, the Secretary of Defense (SECDEF) created the Housing Revitalization Support Office (HRSO). One of HRSO's missions is to explore alternative methods to stimulate privatization that are not subject to the budget scoring requirements of the Budget Enforcement Act of 1990. An entire thesis could be devoted to the innovative privatization efforts of HRSO. As a brief overview, HRSO is currently exploring the following options to stimulate privatization/revitalization: (1) loan/mortgage guarantees, (2) leases, (3) differential payments, (4) investments in non-governmental entities, and (5) limited partnerships.

Through loan/mortgage guarantees, the government guarantees the private developer will make money through mortgage insurance, guaranteed occupancy levels, or direct loans to the developer. In regards to leases, the Service Secretaries may enter into lease contracts to acquire family housing. In this instance, the Government will pay the rents directly to the developer. In the case where member rents do not cover the developer's expenses, the Service Secretaries may enter into contracts that provide for differential payments. These differential payments are designed to increase the financial attractiveness of a given privatization project.

Service Secretaries may invest in non-governmental entities to acquire or construct family housing and the necessary support facilities. These investments may be in the form of limited partnerships, stocks, debt instruments, or a combination of the above.

By far the most radical of HRSO's initiatives is the Limited Partnership Concept. In the limited partnership, the DoD takes no part in management. The DoD may contribute up to 33.3 percent of the cash value of the venture. In lieu of cash, the DoD may also offer up land or buildings as equity. However, the total equity contribution by the DoD cannot exceed 45 percent. Finally, the limited partnership may be used for new construction, renovation, replacement, and construction of necessary housing support facilities.

Why is DoD so interested in privatizing initiatives? DoD currently faces approximately an $11 billion bill to revitalize or replace its existing housing [Ref. 1: p. 2]. The MILCON process is expensive and time consuming. As a result of quality requirements imposed by Congress and DoD, commercially developed real estate is on average, 12 percent less expensive than real estate developed through the MILCON process [Ref. 1: pp. 21,22]. In a time when budget cuts are commonplace, the potential savings from privitization are very attractive.

Related to this cost reduction is the concept of leveraging. By leveraging, an entity is not required to put the entire cost of an investment up front. A common everyday example of leveraging is private home purchasing. In this instance, the purchaser makes a relatively small (5 to 10 percent) down payment and the lender carries the remainder of the loan. MILCON projects are fully funded by congress. In other words, the DoD pays the entire bill for a construction project. Through leveraging, DoD will be able to enter into joint ventures with private developers and only have to pay for a negotiated portion of the entire project cost. Of course, this is an over-simplification of a complex financial transaction. The main point is the DoD will be able to complete a greater number of housing units with the same amount of money it would have spent through MILCON. In addition to the savings in construction costs, the DoD will also be able to enjoy the benefits of shorter completion dates. By obtaining units quicker as

a result of privatization, the DoD will be able to provide more quality housing in a timely manner.

The average age of military family housing is 33 years [Ref. 2: p. 62]. Newer units built as a result of privatization/revitalization will be more modern and consequently, more energy efficient. Advances in building materials, window technology, and energy efficient appliances will result in lower utility costs for the government or service members (in the case they are renting directly them from the developer).

Scenario Two is not without pitfalls or concerns. Shrinking the amount of family housing available will lengthen the waiting time for those accustomed to the "family housing" lifestyle. For more senior members of the military, this probably will not be much of an inconvenience. The junior enlisted members will feel the greatest impact of this move because they rely on family housing to ease their transition to a new duty station.

Of greater concern to the DoD are the impacts of budget scoring as prescribed by the Budget Enforcement Act of 1990. As detailed in Chapter II, the Budget Enforcement Act of 1990 effectively halted the Section 801 and Section 802 housing initiatives. HRSO is working closely with DoD and congressional staffers to develop privatization legislation that will be exempt from budget scoring. Under budget scoring, long term liabilities (such as multi-year leases) must be scored for the full value of the outlay in the first year of the program. According to the PAYGO rules, an increase in discretionary spending must be offset by equal spending cuts in other areas in the discretionary budget.

A final concern in regards to privatization is the notion that service members who are forced to live on the economy will fall victim to unscrupulous landlords. There exists a belief in DoD that once VHA and BAQ rates are published for the year, landlords automatically respond

by raising service members rental rates to take advantage of this fact. Identifying whether this correlation exists is the primary focus of this thesis.

Privatization offers a lot of promise as a solution to the family housing dilemma. However, the budget scoring problem must be solved. With the budget under such scrutiny, it will be difficult to pass legislation that is exempt from the Budget Enforcement Act of 1990. With PAYGO, increases in one discretionary spending area mean offsetting spending cuts in other area of the discretionary spending. If this obstacle can be overcome, privatization through the power of financial leveraging will become the preferred method of housing construction. As a result, the MILCON process will probably be scaled back, impacting the missions of NAVFAC and the Army Corps of Engineers.

C. SCENARIO THREE: ADOPTION OF A TOTAL ALLOWANCE SYSTEM

By far the most radical approach of the three is the adoption of a total allowance system. Converting to a total allowance system would eliminate the need for a vast majority of DoD's current housing inventory. Provisions would probably have to be made for "flag" and "essential personnel" housing. As described earlier, the DoD spends on average, $5,000 more per family in housing than on a family that resides in the private sector. Based on the approximately 300,000 families that live in family quarters, this would represent an annual savings of approximately 1.5 billion dollars.

A change of this magnitude will require a shifting of housing management personnel. Based on this scenario, the new emphasis will be on housing referral, not housing management. Additionally, construction management projects by the Navy Civil Engineer Corps and Army Corps of Engineers will be reduced.

Like the previous scenario, this scenario could prove quite disruptive. Again, the junior enlisted will experience the greatest impact from this change. A young service member faced with moving to an unfamiliar duty station is confronted with numerous challenges. Forcing this member to find quarters on short notice will make this transition all the more difficult.

Another major concern is whether sufficient affordable housing will exist for our service members. Eliminating family housing will result in a greater number of consumers in their respective housing markets. Although military housing could be converted into private sector housing, two potential problems exist. First, the location of some military housing may make a transition to private sector housing impractical. Second, the age and condition of current military housing would make revitalization cost prohibitive for the private sector. As a result, demand for housing will increase. Based on the basic principles of microeconomics, a greater demand for a commodity (in this case housing) will result in increased housing prices. To account for these increased prices, the VHA allowance for the following year will have to be adjusted accordingly. Unfortunately, VHA suffers from a 9 month recognition lag. This phenomena will be discussed in further detail in Chapter V.

Although rent gouging was of concern in scenario two, it is of even greater concern in a scenario which relies on complete private sector housing of our service members. Before the DoD embarks on a transformation of this magnitude, it must be certain that the practice of "rent gouging" does not exist.

A total allowance system does have some distinct advantages: (1) elimination of the DoD's current housing stock, (2) reduction of housing administrative overhead (particularly managerial personnel), and hopefully, (3) cost reduction through allowances which are less than the DoD currently pays to operate its current housing inventory. Although this option offers a lot

of solutions to the current housing shortage, it would prove quite disruptive and have a difficult time being accepted by senior DoD leadership.

D. OTHER POLICY CONCERNS

When determining whether housing is suitable for service members, the idea of Maximum Allowable Housing Cost (MAHC) is considered. By definition, MAHC is equal to 1.5 times a member's BAQ plus the VHA allowance. Under the current system, if a member's rent is greater than the MAHC for his or her location and paygrade, or if a member pays greater than 30 percent in out-ot-pocket expenses, he or she is considered unsuitably housed. For the most part, this condition only exists in high cost areas.

This concept is flawed for the following reasons: (1) it ignores the possibility that the spouse might work, (2) perhaps the member receives a trust fund or other type of supplemental income and finally, (3) the member chooses to live in a particular area because of the quality of schools or overall quality of community. The MAHC has no impact on a member's allowances. It is purely a statistical tool which many housing experts feel is improperly applied. Before the DoD labels someone as being unsuitably housed, it needs to analyze each specific case.

There is a concern that people do not live in similar quality housing around the country. It is believed that people who live in "high cost" areas tend to live below their means to minimize their OOP. Conversely, it is suggested that people who live in low cost regions tend to live above their means. Based on this author's own personal experience, I can confirm this perception. What is the effect of this practice? By living in housing which is not commensurate with one's paygrade, it tends to skew the Local Median Housing Cost (LMHC). As a result, the VHA calculations for that region are either artificially raised in the case of a low cost area or, lowered in the case of a high cost region [Ref. 1: p. 28].

Based on the three scenarios presented and the second policy concern, it is easy to see the importance of accurate VHA computations. If the DoD intends to place a greater reliance on the private sector, it is critical to quantitatively determine if a correlation exists between increases in rent prices and increases in allowances. The next chapter will discuss the data obtained to determine if the above correlation indeed exists.

IV. DATA COLLECTION AND MODEL DEVELOPMENT

This chapter will discuss the methodology used to develop the model necessary to study the correlation between rental increases in the civilian market and DoD housing allowance increases. First, the underlying assumptions used in this analysis will be stated. Second, the data sources and limitations will be discussed. Finally, the specifics of the analytical method will be presented.

A. MODEL ASSUMPTIONS

Based on the fact that family housing is only available to married service members, only the allowances of members with dependents (married service members) were considered. For every given paygrade and location, single and married VHA values are calculated by PDTATAC. Married VHA rates are higher than those for single members. The explanation for this variation is that married members rent larger units of housing to accomodate their families.

Only Continental United States (CONUS) bases and bases located in Hawaii were chosen. Foreign housing was excluded because other factors such as Overseas Housing Allowance (OHA) and overseas Cost of Living Allowances (COLAs), tend to skew the true cost of housing.

In lieu of analyzing every military installation in the United States, a sample of 25 cities was chosen (these are shown in Table 1). This sample of 25 randomly chosen cities represents the entire spectrum of communites in which the Navy is located. On one end of the spectrum, we have major metropolitan cities such as Dallas and New York City,where the Navy represents a rather insignificant portion of the population. In the case of Fallon, NV, and Kingsville, TX, we have communites where the Navy is the largest employer in the community.

San Francisco, CA	Los Angeles, CA	Dallas, TX	Memphis, TN
New Orleans, LA	Great Lakes, IL	Corpus Christi, TX	Kingsville, TX
New York, NY	Orlando, FL	Panama City, FL	Charleston, SC
San Diego, CA	Jacksonville, FL	Norfolk, VA	Washington, DC
Meridian, MS	Gulfport, MS	Fallon, NV	Newport, RI
Port Hueneme, CA	Pensacola, FL	New London, CT	Seattle, WA
Honolulu, HI			

Table 1: List of Cities Analyzed

In an attempt to pare down the sample size, certain ranks were not considered. Warrant officers (W-1 through W-4), Captains (O-6), and Flag Officers (O-7 through O-10) only comprise 1.3 percent of the entire Navy population [Ref. 4]. Consequently, they were not included in the analysis. Finally, the remaining ranks were grouped based on similar housing requirements. The sample was broken down further into the following sub-populations: (1) E-1 thorugh E-4, (2) E-5 and E-6, (3) E-7 through E-9, (4) O-1 through O-3, and (5) O-4 and O-5.

B. DATA COLLECTION

It was the goal of this study to collect data from as many sources as possible. Data sources evaluated included government publications, trade organizations, government organizations, economic consulting firms, and the Internet. Unfortunately, statistics for rental properties are not as readily available as other economic statisics. With this in mind, the research concentrated on two sources.

Collecting data on military housing allowances was relatively straightforward. PDTATAC and the Disbursing Office, Naval Postgraduate School were contacted to obtain housing allowance rates for the years 1989 through 1994.

In collecting rental price data, two sources were evaluated. In the final analysis, only one source was utilized. The Market Analysis Division of Department of Housing, and Urban

Development (HUD) publishes annual Fair Market Rent Data (HUD FMR) for all cities and counties in the United States. By definition, FMR for an area is the amount that would be needed to pay the gross rent (shelter rent plus utilities) of privately owned, decent, safe, and sanitary rental housing of a modest (non-luxury) nature with suitable amenities [Ref. 5]. It must be noted that HUD FMR estimates include utility costs. VHA allowances also account for utility costs.

The manner in which HUD collects its FMR data warrants some attention. In metropolitan areas, the Bureau of Census' American Housing Surveys (AHSs) values are used to develop the baseline. In the years between censuses, the baseline values are corrected by using either the Consumer Price Index (CPI) data for rents and utilities or HUD regional rent change factors measured from Random Digit Dialing (RDD) telephone surveys. Rural areas rely solely on RDDs.

Based on its surveys, HUD publishes Fair Market Rents for zero, one, two, three, and four or more bedroom units at the 40th percentile. The data received from HUD appears to be a weighted average of the five possible scenarios. One might ask how accurate HUD FMR data is. HUD estimates that their RDD telephone surveys are within three to four percent of the actual rent value [Ref. 5].

The second source of rental data considered was data from the consulting firm, Runzheimer. Their data is collected through survey and typically represents the 80th percentile of the housing market. Unfortunately, this data is quite expensive, at roughly $3,500 per year in question and therefore was not pursued. In regards to future research and analysis, it would be interesting to see if using Runzheimer data would alter the conclusion.

C. DATA MANIPULATION

All data was entered into Excel spreadsheets to facilitate processing. Separate spreadsheets were created for the military housing allowance data and the HUD FMR data. Each calendar year was given a separate sheet in the spreadsheet. Using the six years worth of data (1989-1994), five data points were calculated for each location and sub-population (E-1 through E-4, O-1 through O-3, etc.). The following data points were calculated for each city and sub-populations: (1) change from 1989 to 1990, (2) change from 1990 to 1991, (3) change from 1991 to 1992, (4) change from 1992 to 1993, and (5) change from 1993 to 1994. This created 120 data points for each sub-population with the HUD data. To calculate the "net" change for each data point, the average of the individual changes for the sub-population was calculated. Next, the spreadsheets were combined. The government housing allowance was assigned the independent ('X') variable and the HUD FMR data was designated the dependent variable.

D. MODEL DEVELOPMENT

To analyze the correlation between rental increases and housing allowances, three models were developed based on the housing allowance data and HUD FMR data. To perform the necessary regression analysis, the MINITAB Statistical Analysis package was used. Regression analysis is a statistical tool used to determine the mathematical relationship between variables and the statistical significance of the variables in question. Section 5.A will explain how one interprets the results of a regression analysis.

1. Model 1

As a starting point, the first model regressed HUD FMR data against Military Housing Allowance data that was lagged one year. VHA values suffer from a recognition lag of nine months. VHA survey forms are mailed out by PDTATAC in March. The VHA values

calculated from these surveys do not go into effect until January of the following year. To address this fact, the Military Housing Allowance data were lagged one year in the second model. In other words, "change from 1990 to 1991" Military Allowance data were matched to "change from 1989 to 1990" HUD FMR data. The Military Allowance values are equal to the sum of BAQ and VHA for the given city and rank. The BAQ value does not suffer from any recognition lag. This was a definite limitation of the first model.

2. Model 2

In the second model, the military housing allowances were not lagged. In this model, 1990 HUD FMR data was directly compared to 1990 Military Housing allowances, etc.

3. Model 3

To more accurately model the "system", the model needed to be more sophisticated. To fine tune the model, two steps were taken: (1) an additional independent variable was added, and (2) BAQ and VHA were analyzed as separate independent variables. The new independent variable chosen is the ratio of the number of military members (plus family members) to the total population of the city in question. The value of this ratio ranged from 0.002 to 0.532. This improved model was analyzed using the multiple regression capabilities of the MINITAB Statistical Analysis package.

V. ANALYSIS OF RESULTS

This chapter will discuss the correlation between civilian housing prices and military housing allowances determined using linear and multiple regression analysis techniques. The chapter will begin with a quick overview of statistical terms pertinent to regression analysis. Finally, the results of the three individual models will be discussed in detail. Data plots (where applicable) and detailed MINITAB output sheets for the three models appear in Appendices A and B.

A. STATISTICAL TERMINOLOGY USED IN REGRESSION ANALYSIS

When analyzing the results from a regression analysis, three statistical values are of great interest to the statistician or manager. The first of these, the t-ratio, is a measure of whether an independent variable belongs in a regression model. For an independent variable to be statistically significant at the 95 percent confidence level, its t-ratio must be greater than the critical value, which is approximately, 2 unless the sample size is very small (the sign of the t-ratio is the same as the sign of the coefficient).

The f-statistic is a measure of how well the selected set of independent variables model the system. If the f-statistic of a regression model is less than the critical value (approximately 4 at the 95 percent confidence level), the chosen independent variables do not correctly model the system in question.

The coefficient of determination, or R^2 as it is commonly called, gives one an idea of how accurately the calculated function represents the data. By definition, the coefficient of determination represents the proportion of the sample variability of the dependent variable explained by its linear relationship with the independent variable(s) [Ref. 6: p. 454]. Values for

R^2 range from zero to one. Quite often, the value of R^2 is represented as a percentage ranging from 0 to 100%. In regards to statistical analysis, the greater the R^2, the better. As an illustration, a perfect linear function has an R^2 of 1.00. The statistical significance of the R^2 is measured by the f-statistic mentioned above, but the analyst must determine an acceptable R^2 threshold based on the importance of the decision impacted by the analysis.

B. ANALYSIS OF RESULTS

Table 2 details the results of the linear regression performed on Model One:

Model One Regression Analysis

	Regression Equation				Statistical Analysis	
Population	a	b	t-ratio, a	t-ratio, b	f-statistic	R^2
E1-E4	18.9	0.079	6.58	0.91	0.83	0.8%
E5-E6	18.3	0.084	6.17	1.17	1.36	1.4%
E7-E9	17.5	0.099	6.2	1.72	2.97	3.0%
O1-O3	18.6	0.068	6.82	1.24	1.53	1.6%
O4-O5	18.6	0.051	7.3	1.48	2.2	2.2%

Notes:

(1) Data Source = HUD Fair Market Rent Data
(2) a = y-intercept
(3) b = slope of regression line

Table 2: Model One Regression Analysis

Model 1 lagged the entire housing allowance (BAQ + VHA). As detailed in the previous chapter, the VHA allowance is the only entitlement that suffers from recognition lag. The results of this analysis shows this approach to modeling the system is flawed. According to the statistical criteria discussed in section 5.A, the values for t_a, are acceptable. Unfortunately, t_a is a measure of the constant term, not the independent variable. The t-ratio for the independent variable (t_b) is of greater concern and is extremely low, as Figure 1 shows. Furthermore, the f-

statistic is well below 4 for the five sub-populations in question. Finally, the R^2 values for this model are almost equal to zero. One can conclude that the relationship between increases in civilian rental prices and increases in military housing allowances does not exist statistically for each of the populations according to Model 1.

Model 2 used the same data without lagging the housing allowance data. Table 3 details the results of this analysis:

Model Two Regression Analysis

	Regression Equation		Statistical Analysis			
Population	**a**	**b**	**t-ratio, a**	**t-ratio, b**	**f-statistic**	**R^2**
E1-E4	11.3	0.391	3.42	3.67	13.48	9.9%
E5-E6	12.7	0.253	3.62	2.79	7.77	6.0%
E7-E9	12.7	0.240	3.91	3.21	10.33	7.8%
O1-O3	13.5	0.216	4.34	3.17	10.04	7.6%
O4-O5	14.9	0.116	4.9	2.68	7.19	5.6%

Notes:

(1) Data Source = HUD Fair Market Rent Data
(2) a = y-intercept
(3) b = slope of regression line

Table 3: Model Two Regression Analysis

This model is an improvement over the previous attempt. The t-ratios for all sub-populations are statistically significant. Also, the f-statistics are well above the critical value. However, the R^2 values are still extremely low. The interpretation of this scenario is as follows: A correlation between rental price increases and housing allowance increases exists, but, it is an extremely weak correlation. In other words, DoD housing allowances explain less than 10% of the variation in civilian rental changes.

In an attempt to separate the housing allowance components and investigate the effect of the military's presence in a given geographical area, Model 3 was developed. By far the most

sophisticated model developed, BAQ and VHA are treated as separate independent variables. A new independent variable, %POP, was created by taking the number of military members (plus family members) and dividing this quantity by the population of the area in question. This resulted in a multiple regression with three independent variables (BAQ, VHA, and %POP). The statistical results (t-ratios, f-statistics, and R^2s) of this regression appear in Table 4. For the actual coefficients calculated for the independent variables, please refer to Appendix B.

Model Three Regression Analysis

Population	t-ratio, BAQ	t-ratio, VHA	t-ratio, %POP	f-stat	R^2
E1-E4	-1.22	6.33	-2.22	14.61	26.8%
E5-E6	-1.21	6.37	-2.23	14.8	27.0%
E7-E9	-1.61	6.44	-2.22	15.1	27.4%
O1-O3	-1.13	5.88	-1.76	12.75	24.2%
O4-O5	-0.97	4.98	-1.56	9.4	19.0%

Note: (1) Data Source = HUD Fair Market Rent

Table 4: Model Three Regression Analysis

The f-statistic for this model is strong for all five sub-populations. As expected, the VHA independent variable shows a strong statistical significance for all the sub-populations in question. This fact can be explained by the fact VHA values are based on VHA surveys. These surveys are based on actual rents paid by service members and most closely reflect the civilian rental market. In regards to the BAQ independent variable, the t-ratio was statistically insignificant for all sub-populations. This occurrence can likely be attributed to the fact that BAQ increases are generated at the national level and do not reflect local housing market prices. The effect of the %POP independent variable is very interesting for two reasons.

First, %POP is statistically significant in the enlisted sub-populations but statistically insignificant in the officer sub-populations. Intuitively, this makes sense. As stated earlier,

HUD FMR data is based on the 40th percentile of the rental population. With the exception of some of the most senior E-8 and E-9 personnel, officers earn more money than members of the enlisted community. Consequently, officers tend to search for housing of a higher quality and price. Furthermore, enlisted personnel outnumber officers at a rate of roughly seven enlisted personnel to one officer.

The second observation related to the %POP independent variable is the fact that its t-ratio and consequently, its coefficient is negative. This negative value of the coefficient suggests that as civilian rental prices increase, military members tend to search for other shelter arrangements (family housing, purchasing of private residences). Three possible explanations for this phenomenon are offered: (1) the personnel drawdown in the military has made more military family housing available to qualified members, (2) annual MILCON projects have increased the family housing inventory, and (3) the financial advantages of home ownership has attracted more service members.

Although this model was very promising in the areas of the f-statistic, and t-ratios for VHA and %POP (enlisted community), it was rather disappointing in regards to the value of R^2. Realistically, a R^2 of approximately 27.4% is still weak when trying to determine whether a correlation exists between housing prices and increases in housing allowances.

C. OVERALL ANALYSIS OF RESULTS

Overall, the results suggest that a weak correlation exists between civilian rental price increases and increases in military housing allowances. Consequently, one must be extremely cautious when discussing the existence of the correlation for policy making purposes. At best, an R^2 of approximately 27.4 percent was obtained in analysis of Model Three. The implications of this correlation will be discussed in the following chapter.

VI. CONCLUSIONS AND RECOMMENDATIONS

The first section of this chapter will discuss the policy implications of the correlation between civilian rental housing prices and DoD Housing changes determined in the previous chapter. Section two of the chapter will discuss the limitations of the current study and provide recommendations to improve the current model for follow-on research. In the final section, concluding remarks will be presented.

A. POLICY IMPLICATIONS

Based on the fact that the highest R^2 obtained from this study equaled 27.4 percent, further study is recommended to determine if a stronger correlation exists and the overall effects of the correlation. An R^2 of 27.4 percent means that the independent variables selected for model three only explain 27.4 percent of the variability in the dependent variable. In other words, the model developed fails to explain 72.6 percent of the variability in the data set. Consequently, in its current form, this model is less than reliable for important policy decisions that will affect the well being of hundreds of thousands of military personnel.

As detailed in earlier chapters, contemporary thinking in regards to the future of family housing is leaning towards privatization efforts. Based solely on cost benefit analysis data, some have suggested that the DoD should completely divest itself of its housing inventory and current family housing responsibilities. No matter which path DoD chooses, an increased reliance on the private sector to provide family housing will be required.

This thesis should be viewed as a starting point for a more in-depth analysis into whether landlords adjust rental prices based on increases in military housing allowances. The relatively low R^2 values suggest that a weak correlation does exist, as modeled in this study. A more

sophisticated model may be needed to see if there exists a stronger relationship between military allowance increases and civilian rental prices. If further study shows similar results, then it implies that the impact of military housing allowance increases plays a minor role in civilian rental price changes. Consequently, the following section will provide recommendations for improving the current multiple regression model.

B. LIMITATIONS OF EXISTING ANALYTICAL MODEL AND PROPOSED IMPROVEMENTS

Data pertaining to BAQ and VHA rates for service members was readily available from PDTATAC. Unfortunately, data for civilian rental prices was not as readily available. The actual rental price data used in the model was HUD Fair Market Rent data (HUD FMR). In theory, HUD FMR data is available for a given location, broken down into the following sub-categories: (1) zero bedroom, (2) one bedroom, (3) two bedroom, (4) three bedroom, and (5) four or more bedroom units. The data provided by HUD was a single value for each city in question. This value appears to be an average cost for the available types of housing.

To improve the sophistication of the model, follow-on researchers should obtain the complete HUD FMR data set for each city in question. Using this data, the sub-populations could be matched with an appropriate sized unit of housing. For example, the E-1 through E-4 housing allowance data could be compared to HUD one or two bedroom price data. On the other end of the spectrum, the O-4 and O-5 housing allowance data could be compared to three bedroom or four or more bedroom HUD FMR data.

To improve on what this study has accomplished, an additional source or sources of rental price data must be sought. The consulting firm Runzheimer is a possibility for this purpose. NAVFAC Code 50 has purchased limited quantities of Runzheimer data in the past. As noted in Chapter IV, Runzheimer data costs approximately $3,500 per year in question.

What will be gained by using Runzheimer data? Based on interviews with NAVFAC Code 50 personnel, Runzheimer data is based on the 80th percentile of rental housing costs for a given location. Given the fact that HUD FMR data is based on the 40th percentile and Runzheimer data is based on the 80th percentile, the expansion of the data set would more accurately model the renting characteristics of service members. Obtaining six years worth of Runzheimer data would cost approximately $21,000. Considering the magnitude of the financial implications of the policy issues being addressed, this cost is insignificant.

The fact that the chosen independent variables of BAQ, VHA, and %POP only explain approximately 25% (depending on the sub-population) of the variability suggests that either the model may be improved by using a more refined data set or the civilian rental prices in communities with heavy military presence are influenced more by other factors than by DoD housing allowance policies.

A logical first choice would be a measure of how much rental housing is available in the private sector at a given location. An availability index is such a measure. For instance, an availability index of 5 percent would suggest that 95 percent of the rental housing market is occupied.

Expensive communities such as Monterey, CA, and San Francisco, CA make living in family housing very attractive from a financial perspective. As discussed in previous chapters, BAQ and VHA entitlements are only designed to cover 80 percent of one's housing expenditures. In high cost areas such as Monterey and San Francisco, the 20 percent the member pays in OOP can be significant. Conversely, a service member living in Meridian, MS would face much less significant OOP costs because of the low cost of living. Naturally, members stationed in Monterey would desire family housing, whereas members in Meridian might be indifferent.

To incorporate this behavior in the model, a Cost of Living ratio independent variable would have to be incorporated into the model. Mathematically, the ratio would appear as follows:

$$\frac{(\text{Cost of Living rating})_{\text{local}}}{(\text{Cost of Living rating})_{\text{national median}}}$$

PDTATAC currently possesses the data to calculate this ratio. As a refresher, VHA is calculated based on two values, National Median Housing Cost (NMHC) and Local Median Housing Cost (LMHC). By simply dividing the LMHC by the NMHC, a useful ratio would be calculated. It would be relatively straightforward for PDTATAC to calculate this ratio for each paygrade at each duty station at the same time it calculates its annual VHA rates.

The number of available units of family housing at a given base clearly influences whether a service member chooses to live on base or off-base. A manner in which one might model this behavior could entail comparing the number of married family members assigned to a base to the number of available family housing units. This analysis could be further broken down into officer and enlisted sub-populations.

One of the assumptions in the current analytical model assumed the military populations at the bases in question remained constant for the years in question (1989-1994). Based on end-strength drawdowns and Base Realignment and Closure (BRAC) legislation enacted over this period, this assumption is not completely correct. The %POP independent variable assumed constant military population for the period in question. Another factor is the fact that the census is only taken every 10 years. Consequently, the denominator of the %POP ratio remains constant while the numerator (military population) changes. When viewing the model as a whole, the effects of this assumption are probably insignificant. However, if one requires greater accuracy, one could obtain the actual military populations for the cities in question from BUPERS or Chief, Navy Office of Information (CHINFO).

C. CLOSING REMARKS

Housing the nation's service members is a complex issue. Economic benefits of providing or not providing family housing must be carefully weighed against Quality of Life issues which are so prevalent in today's political climate. The purpose of this thesis was to analyze an important concern of the military family community and to provide initial findings, and more importantly, recommendations for further follow-on research. It was never the intention of this thesis to provide an algorithmic or "cookie cutter" solution to this complex problem

To lower its family housing expenses, DoD must investigate alternative housing solutions. Privatization and other housing initiatives are clearly the wave of the future. Before the DoD can embark on any plan that places a greater reliance on private sector housing, the DoD must be certain that the quality of life for its service members will not be diminished. The DoD must carefully weigh its potential cost savings (by eliminating current units of family housing) against the potential problems as a result of forcing our service members to live in the private sector.

A concern to the DoD is the issue of whether the private housing market has sufficient capacity to absorb additional renters if the DoD decides to utilize Privatization, or in the extreme case, a complete divestiture of its housing inventory. As mentioned in Chapter III, not all family housing units divested by the DoD may be suitable for reutilization by the private sector. Consequently, further research in this area is required to determine if sufficient capacity exists in the private sector.

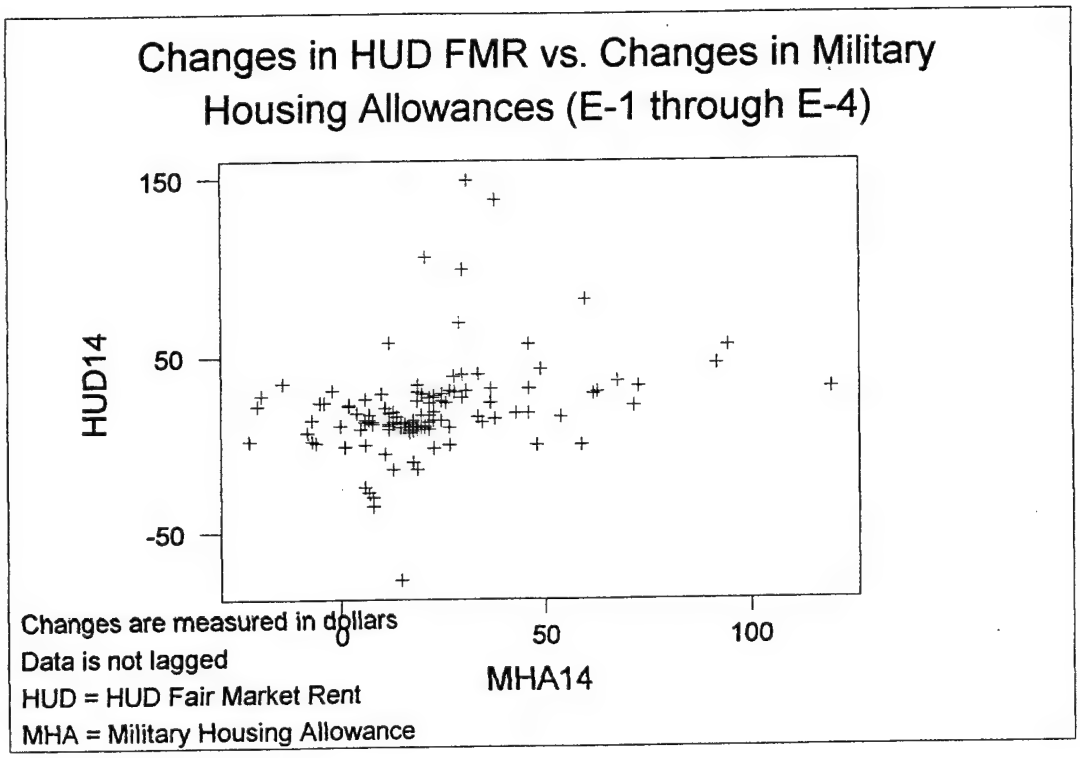
Of equal, if not greater concern, is the issue of whether landlords will take advantage of service members in regards to rents charged to service members. This critical issue was the

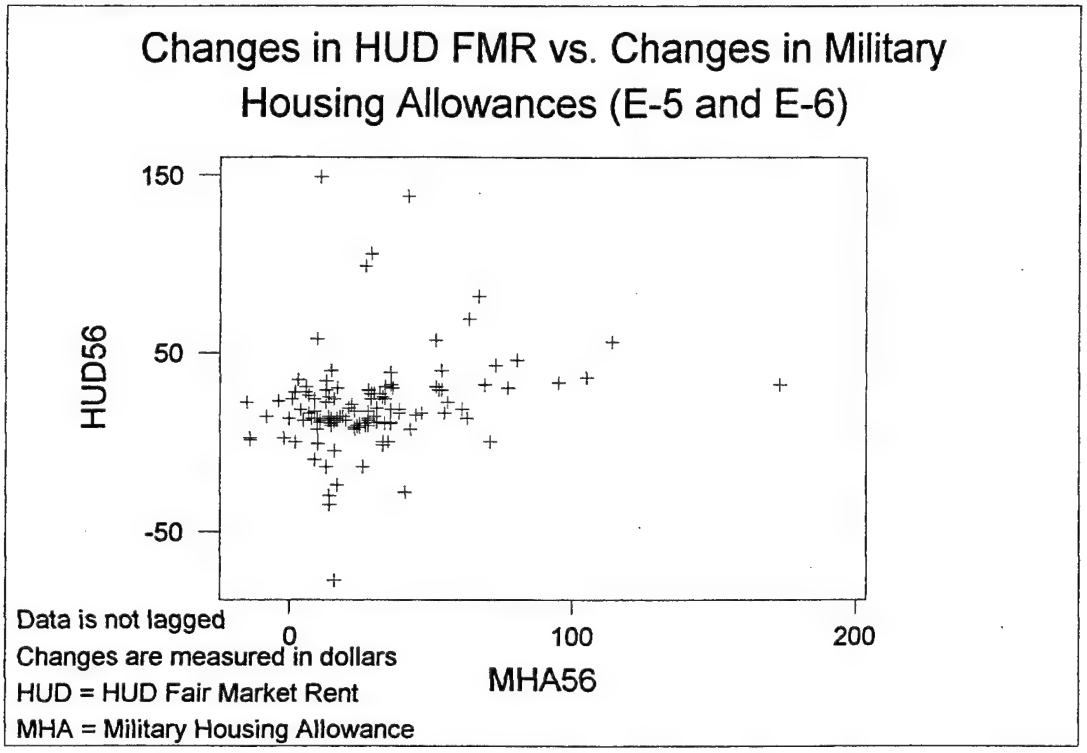
emphasis of this thesis. Before this thesis, very little, if any quantitative research was conducted to determine if landlords charged rents based on changes in military housing allowances.

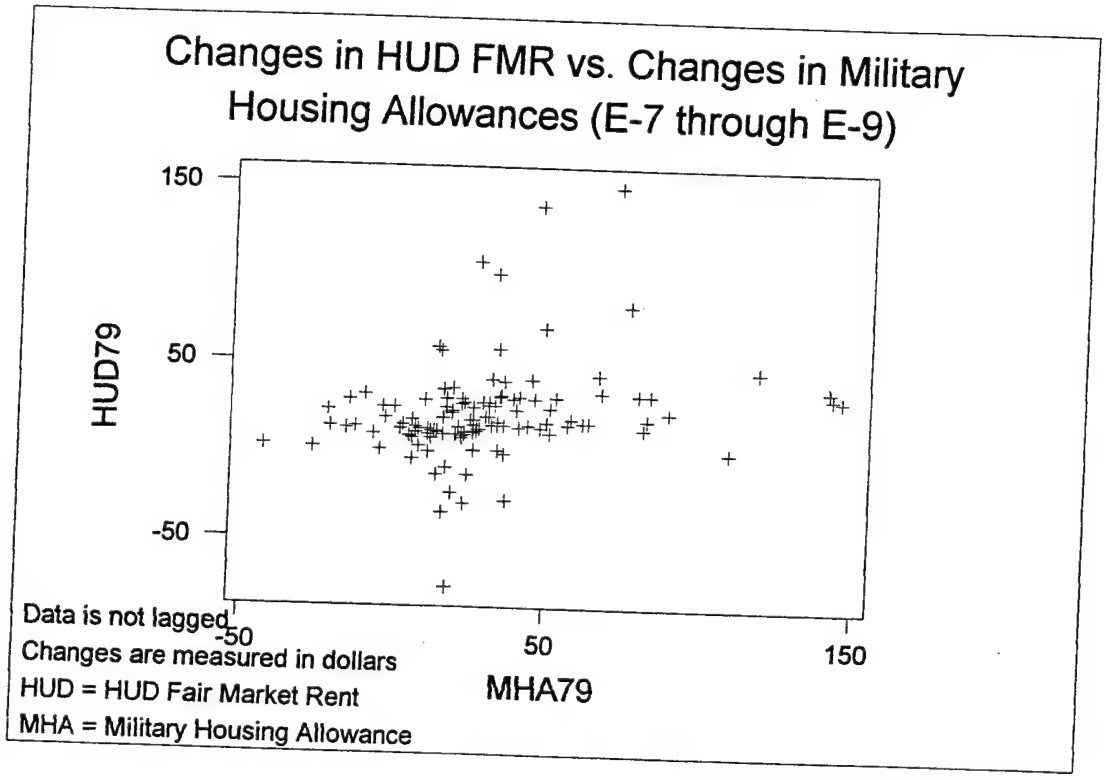
Even though this research was subject to time and financial constraints, the initial findings are very encouraging. The independent variables of VHA and %POP were found to be relevant factors in determining whether a correlation exists between increases in civilian rental prices and changes in military housing allowances. It confirms the common perception that, in communities with significant military presence, the relationship does exist, albeit a weak one. In regards to follow-on research, this thesis provides solid recommendations to further improve the analytical model developed.

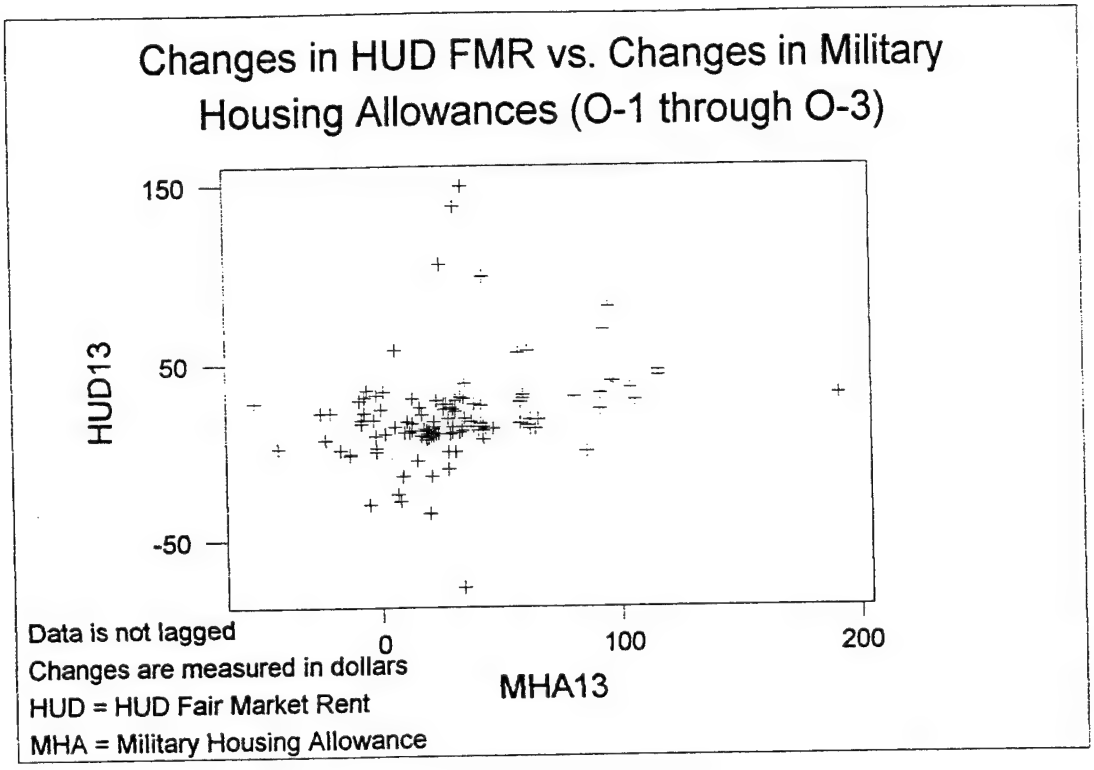
The challenges associated with providing cost effective, quality housing to service members will not go away. Faced with decreasing budgets and an increased emphasis toward Quality of Life issues, the DoD needs to develop solutions to its housing challenges as quickly as possible. It is hoped that this research can provide a solid starting point for follow-on research to help DoD solve its housing challenges.

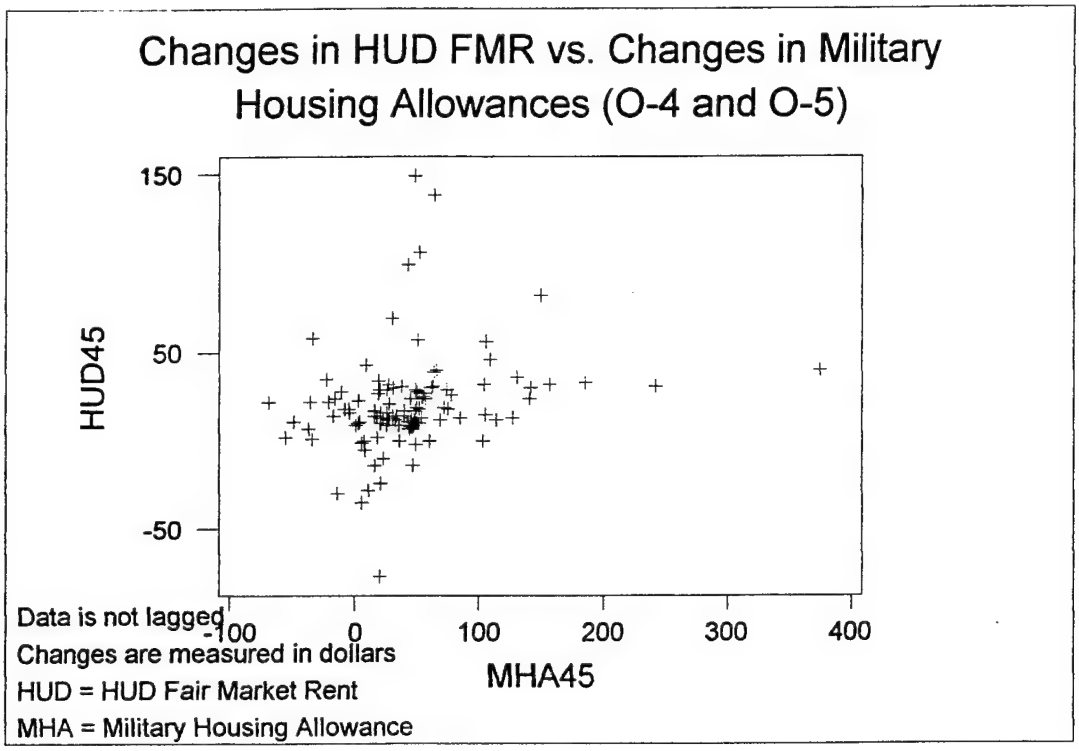
APPENDIX A. MINITAB PLOTS

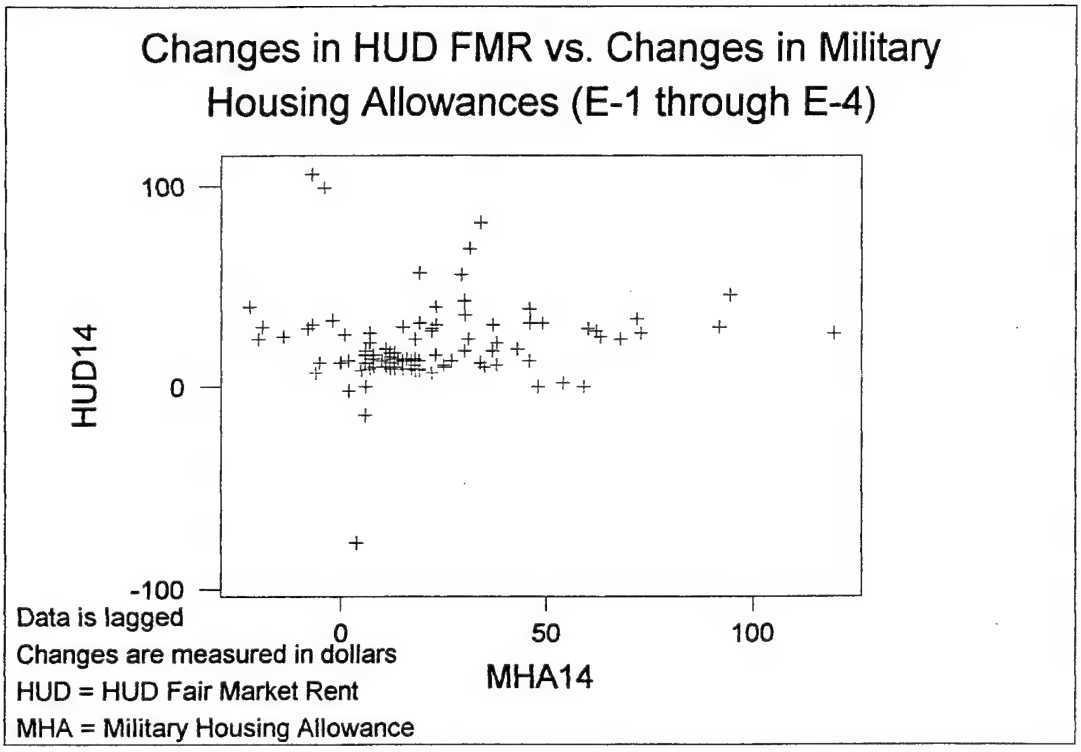


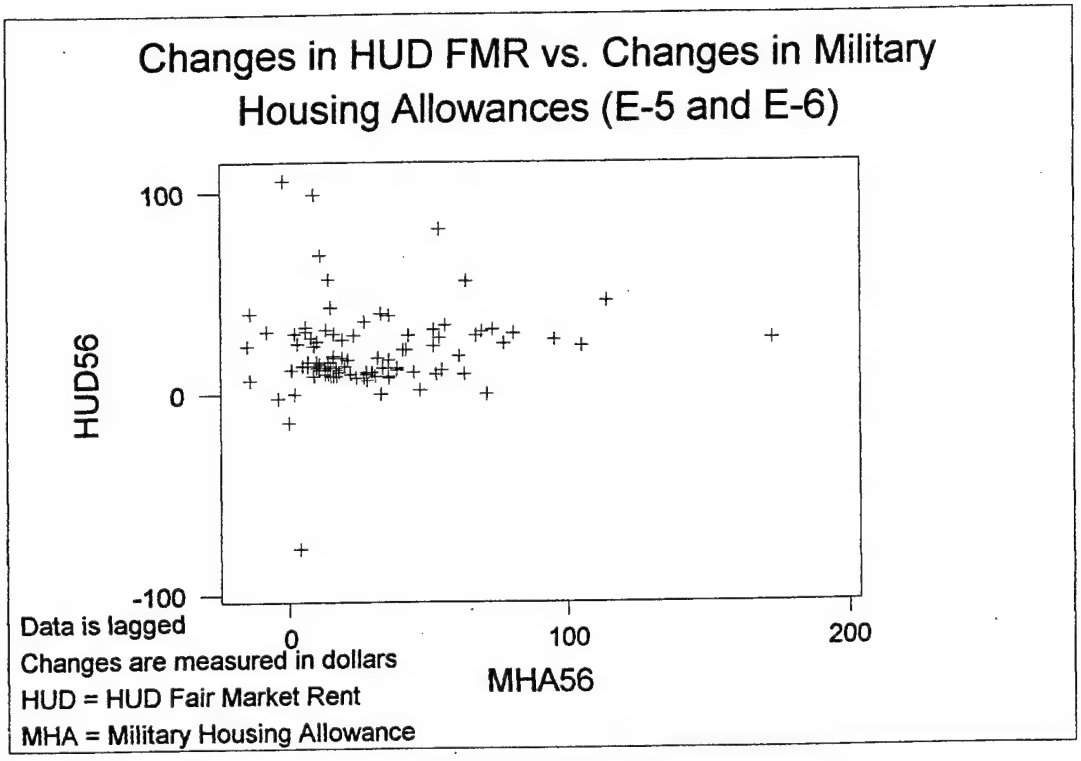

Changes in HUD FMR vs. Changes in Military Housing Allowances (E-5 and E-6)
150
50
-50
HUD56
0
100
200
MHA56
Data is not lagged
Changes are measured in dollars
HUD = HUD Fair Market Rent
MHA = Military Housing Allowance

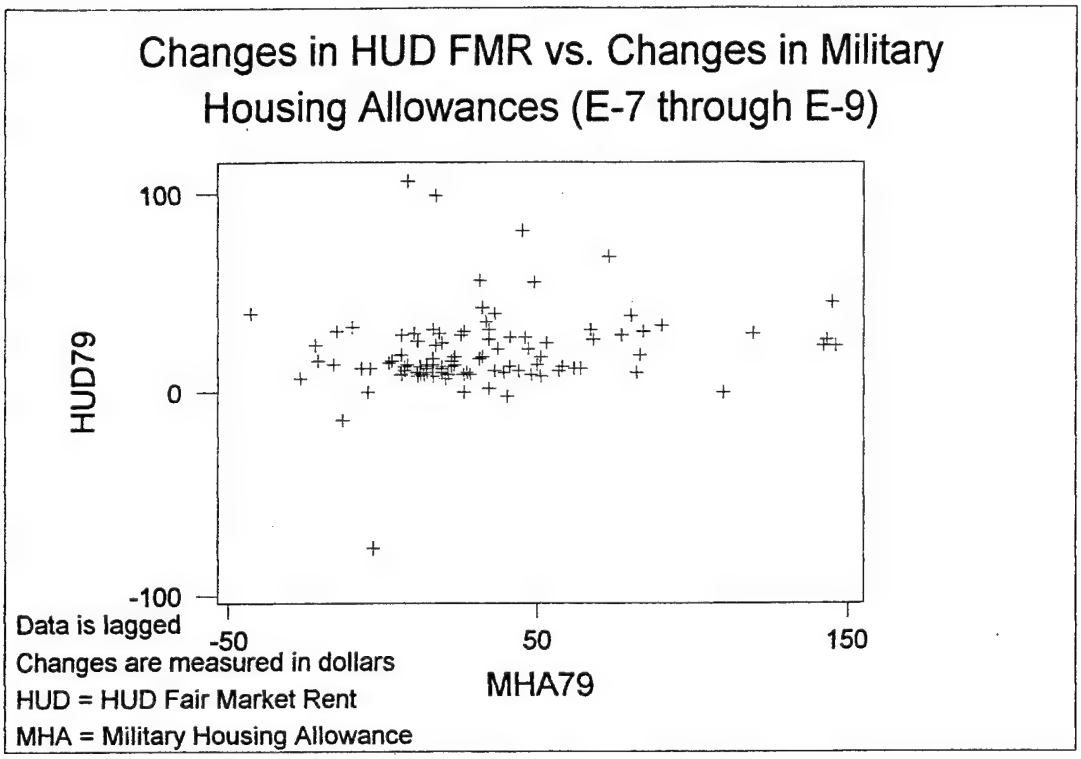

Changes in HUD FMR vs. Changes in Military Housing Allowances (E-7 through E-9)
150
50
-50
HUD79
-50
50
150
MHA79
Data is not lagged
Changes are measured in dollars
HUD = HUD Fair Market Rent
MHA = Military Housing Allowance

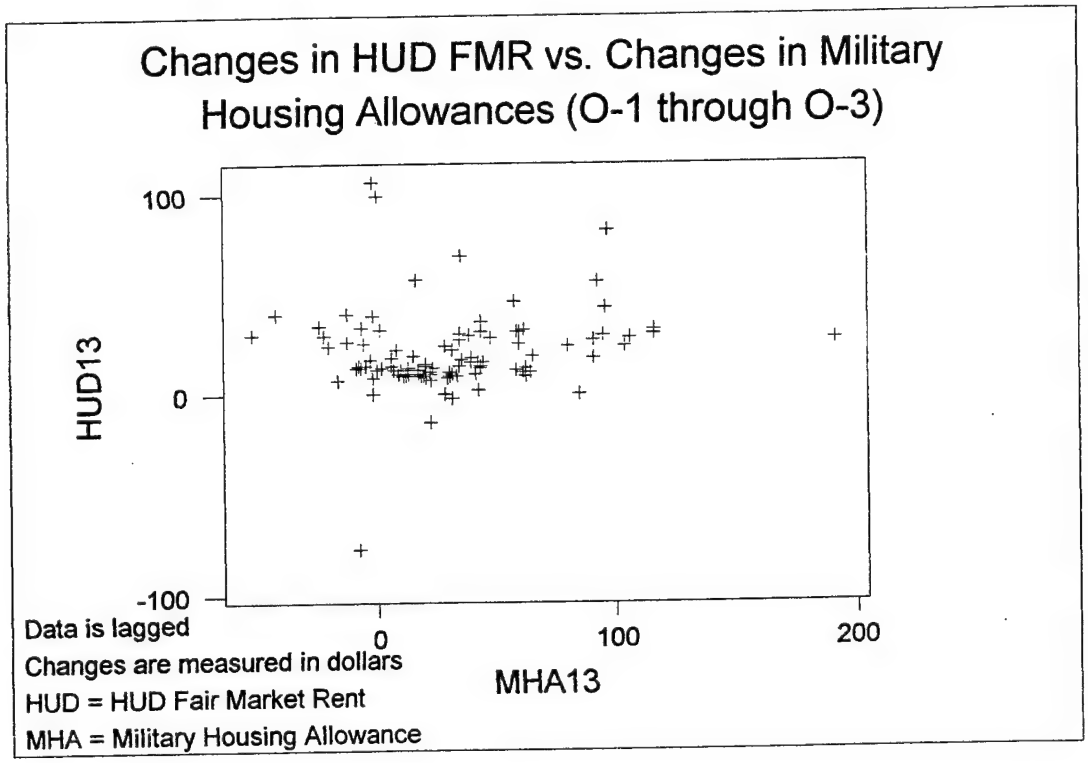

Changes in HUD FMR vs. Changes in Military Housing Allowances (O-1 through O-3)
150
50
-50
HUD13
0
100
200
MHA13
Data is not lagged
Changes are measured in dollars
HUD = HUD Fair Market Rent
MHA = Military Housing Allowance

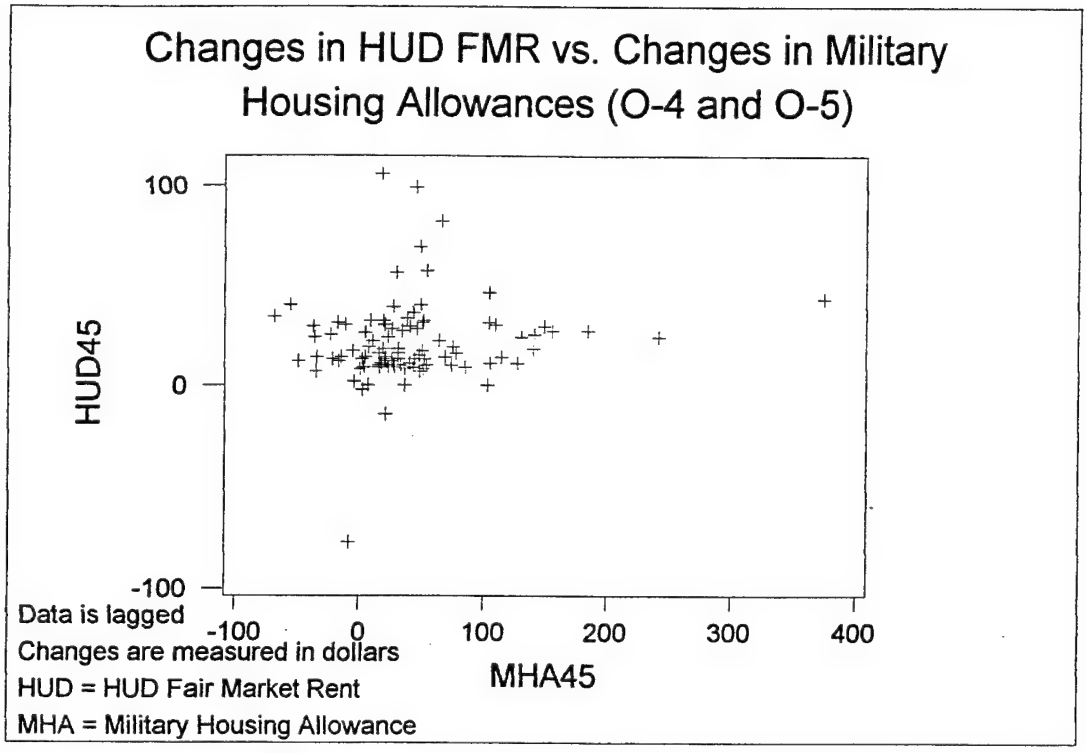

Changes in HUD FMR vs. Changes in Military Housing Allowances (O-4 and O-5)
HUD45
150
50
-50
-100
0
100
200
300
400
MHA45
Data is not lagged
Changes are measured in dollars
HUD = HUD Fair Market Rent
MHA = Military Housing Allowance


Changes in HUD FMR vs. Changes in Military Housing Allowances (E-1 through E-4)
HUD14
100
0
-100
0
50
100
MHA14
Data is lagged
Changes are measured in dollars
HUD = HUD Fair Market Rent
MHA = Military Housing Allowance


Changes in HUD FMR vs. Changes in Military Housing Allowances (E-5 and E-6)
100
0
-100
HUD56
0
100
200
MHA56
Data is lagged
Changes are measured in dollars
HUD = HUD Fair Market Rent
MHA = Military Housing Allowance


Changes in HUD FMR vs. Changes in Military Housing Allowances (E-7 through E-9)
100
0
-100
HUD79
-50
50
150
MHA79
Data is lagged
Changes are measured in dollars
HUD = HUD Fair Market Rent
MHA = Military Housing Allowance


Changes in HUD FMR vs. Changes in Military Housing Allowances (O-1 through O-3)
HUD13
100
0
-100
0
100
200
MHA13
Data is lagged
Changes are measured in dollars
HUD = HUD Fair Market Rent
MHA = Military Housing Allowance


Changes in HUD FMR vs. Changes in Military Housing Allowances (O-4 and O-5)
HUD45
100
0
-100
-100
0
100
200
300
400
MHA45
Data is lagged
Changes are measured in dollars
HUD = HUD Fair Market Rent
MHA = Military Housing Allowance

APPENDIX B. MINITAB REGRESSION OUTPUTS

```
MTB > Retrieve  'A:\VHAMOD.MTW'.
Retrieving worksheet from file: A:\VHAMOD.MTW
Worksheet was saved on 10/ 7/1996
MTB > note this regression is being performed on non-lagged
MTB > note data and includes HI data
MTB >
MTB > note e1-e4 sub-population
MTB >
MTB > regr c1 1 c2

The regression equation is
ave14y = 11.3 + 0.391 ave14x

124 cases used 1 cases contain missing values

Predictor       Coef       Stdev    t-ratio        p
Constant      11.301       3.302       3.42    0.001
ave14x        0.3908      0.1065       3.67    0.000

s = 25.78       R-sq = 9.9%      R-sq(adj) = 9.2%

Analysis of Variance

SOURCE        DF          SS          MS          F        p
Regression     1      8959.6      8959.6      13.48    0.000
Error        122     81103.0       664.8
Total        123     90062.6

Unusual Observations
Obs.    ave14x     ave14y        Fit  Stdev.Fit    Residual    St.Resid
  3         21     106.00      19.51       2.32       86.49      3.37R
 33        119      32.00      57.81      10.57      -25.81     -1.10 X
 47         73      33.00      39.83       5.89       -6.83     -0.27 X
 64         30      99.00      23.03       2.46       75.97      2.96R
 77         15     -77.00      17.16       2.44      -94.16     -3.67R
 81         72      22.00      39.44       5.79      -17.44     -0.69 X
105         38     138.00      26.15       2.87      111.85      4.37R
122         92      46.00      47.22       7.78       -1.22     -0.05 X
123         95      56.00      48.27       8.06        7.73      0.32 X
125         31     149.00      23.53       2.51      125.47      4.89R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >
MTB > note e5-e6 sub-population
MTB >
MTB > regr c3 1 c4

The regression equation is
ave56y = 12.7 + 0.253 ave56x

124 cases used 1 cases contain missing values

Predictor       Coef       Stdev    t-ratio        p
Constant      12.710       3.511       3.62    0.000
ave56x       0.25298     0.09073       2.79    0.006
```

s = 26.34 R-sq = 6.0% R-sq(adj) = 5.2%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	5395.0	5395.0	7.77	0.006
Error	122	84667.6	694.0		
Total	123	90062.6			

Unusual Observations

Obs.	ave56x	ave56y	Fit	Stdev.Fit	Residual	St.Resid
3	29	106.00	20.05	2.37	85.95	3.28R
33	173	32.00	56.48	13.31	-24.48	-1.08 X
40	105	36.00	39.27	7.33	-3.27	-0.13 X
47	95	33.00	36.74	6.47	-3.74	-0.15 X
48	67	82.00	29.66	4.21	52.34	2.01R
64	27	99.00	19.54	2.37	79.46	3.03R
77	16	-77.00	16.76	2.63	-93.76	-3.58R
105	42	138.00	23.33	2.66	114.67	4.37R
123	114	56.00	41.57	8.11	14.43	0.58 X
125	11	149.00	15.52	2.85	133.48	5.10R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

```
MTB >
MTB > note e7-e9 sub-population
MTB >
MTB > regr c5 1 c6
```

The regression equation is
ave79y = 12.7 + 0.240 ave79x

124 cases used 1 cases contain missing values

Predictor	Coef	Stdev	t-ratio	p
Constant	12.704	3.250	3.91	0.000
ave79x	0.23990	0.07465	3.21	0.002

s = 26.09 R-sq = 7.8% R-sq(adj) = 7.0%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	7029.5	7029.5	10.33	0.002
Error	122	83033.1	680.6		
Total	123	90062.6			

Unusual Observations

Obs.	ave79x	ave79y	Fit	Stdev.Fit	Residual	St.Resid
3	27	106.00	19.18	2.35	86.82	3.34R
30	146	31.00	47.73	8.96	-16.73	-0.68 X
33	143	32.00	47.01	8.74	-15.01	-0.61 X
40	142	36.00	46.77	8.67	-10.77	-0.44 X
45	110	0.00	39.09	6.40	-39.09	-1.55 X
64	33	99.00	20.62	2.35	78.38	3.02R
77	18	-77.00	17.02	2.51	-94.02	-3.62R
97	-43	2.00	2.39	5.94	-0.39	-0.02 X
105	47	138.00	23.98	2.66	114.02	4.39R
122	119	46.00	41.35	7.06	4.65	0.19 X

```
125        73      149.00       30.19        3.96      118.81        4.61R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >
MTB > note 01-03 sub-population
MTB >
MTB > regr c7 1 c8

The regression equation is
ave13y = 13.5 + 0.216 ave13x

124 cases used 1 cases contain missing values

Predictor       Coef      Stdev    t-ratio       p
Constant      13.483      3.108       4.34   0.000
ave13x       0.21623    0.06823       3.17   0.002

s = 26.12       R-sq = 7.6%      R-sq(adj) = 6.8%

Analysis of Variance

SOURCE        DF          SS          MS         F       p
Regression     1      6849.5      6849.5     10.04   0.002
Error        122     83213.1       682.1
Total        123     90062.6

Unusual Observations
Obs.    ave13x      ave13y         Fit  Stdev.Fit    Residual     St.Resid
  3        25      106.00       18.89       2.37       87.11       3.35R
 33       191       32.00       54.78      11.24      -22.78      -0.97 X
 49       116       43.00       38.57       6.33        4.43       0.18 X
 64        43       99.00       22.78       2.51       76.22       2.93R
 68       -53       28.00        2.02       6.12       25.98       1.02 X
 77        34      -77.00       20.83       2.36      -97.83      -3.76R
103        20      -35.00       17.81       2.44      -52.81      -2.03R
105        31      138.00       20.19       2.35      117.81       4.53R
122       116       46.00       38.54       6.32        7.46       0.29 X
125        35      149.00       20.99       2.37      128.01       4.92R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >
MTB > note o4-o5 sub-population
MTB >
MTB > regr c9 1 c10

The regression equation is
ave45y = 14.9 + 0.116 ave45x

124 cases used 1 cases contain missing values

Predictor       Coef      Stdev    t-ratio       p
Constant      14.866      3.034       4.90   0.000
ave45x       0.11597    0.04325       2.68   0.008

s = 26.40       R-sq = 5.6%      R-sq(adj) = 4.8%
```

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	1	5012.6	5012.6	7.19	0.008
Error	122	85050.0	697.1		
Total	123	90062.6			

Unusual Observations

Obs.	ave45x	ave45y	Fit	Stdev.Fit	Residual	St.Resid
3	52	106.00	20.90	2.40	85.10	3.24R
30	242	31.00	42.93	8.89	-11.93	-0.48 X
47	185	33.00	36.32	6.55	-3.32	-0.13 X
64	43	99.00	19.85	2.37	79.15	3.01R
73	375	40.00	58.35	14.52	-18.35	-0.83 X
77	20	-77.00	17.19	2.58	-94.19	-3.58R
105	64	138.00	22.29	2.53	115.71	4.40R
125	49	149.00	20.49	2.38	128.51	4.89R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >

```
Worksheet size: 3500 cells

MTB > Retrieve  'A:\VHALAG.MTW'.
Retrieving worksheet from file: A:\VHALAG.MTW
Worksheet was saved on 10/ 7/1996
MTB > note this regression is being performed on lagged data
MTB >
MTB > regr c1 1 c2

The regression equation is
ave14y = 18.9 + 0.0794 ave14x

99 cases used 1 cases contain missing values

Predictor       Coef      Stdev    t-ratio       p
Constant      18.926      2.876       6.58   0.000
ave14x       0.07941    0.08724       0.91   0.365

s = 21.07       R-sq = 0.8%      R-sq(adj) = 0.0%

Analysis of Variance

SOURCE       DF          SS          MS          F       p
Regression    1       367.8       367.8       0.83   0.365
Error        97     43051.2       443.8
Total        98     43418.9

Unusual Observations
Obs.   ave14x     ave14y        Fit  Stdev.Fit   Residual     St.Resid
  3       -7     106.00      18.37       3.32      87.63       4.21R
  9      119      27.00      28.38       8.70      -1.38      -0.07 X
 48       34      82.00      21.63       2.35      60.37       2.88R
 64       -4      99.00      18.61       3.12      80.39       3.86R
 77        4     -77.00      19.24       2.65     -96.24      -4.61R
 97       92      30.00      26.22       6.43       3.78       0.19 X
 98       95      46.00      26.44       6.65      19.56       0.98 X
100       31      69.00      21.41       2.26      47.59       2.27R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >
MTB > note e5-e6 sub-population
MTB >
MTB > regr c3 1 c4

The regression equation is
ave56y = 18.3 + 0.0847 ave56x

99 cases used 1 cases contain missing values

Predictor       Coef      Stdev    t-ratio       p
Constant      18.273      2.961       6.17   0.000
ave56x       0.08472    0.07255       1.17   0.246

s = 21.01       R-sq = 1.4%      R-sq(adj) = 0.4%

Analysis of Variance

SOURCE       DF          SS          MS          F       p
```

```
Regression      1        601.9        601.9       1.36     0.246
Error          97      42817.0        441.4
Total          98      43418.9

Unusual Observations
Obs.    ave56x     ave56y        Fit   Stdev.Fit    Residual     St.Resid
  3        -2     106.00      18.10        3.06       87.90       4.23R
  9       173      27.00      32.93       10.69       -5.93      -0.33 X
 16       105      24.00      27.17        5.93       -3.17      -0.16 X
 23        95      27.00      26.32        5.26        0.68       0.03 X
 48        54      82.00      22.85        2.80       59.15       2.84R
 64         9      99.00      19.04        2.55       79.96       3.83R
 77         4     -77.00      18.61        2.77      -95.61      -4.59R
 98       114      46.00      27.94        6.55       18.06       0.90 X
100        11      69.00      19.21        2.46       49.79       2.39R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >
MTB > note e7-e9 sub-pop
MTB >
MTB > regr c5 1 c6

The regression equation is
ave79y = 17.5 + 0.0988 ave79x

99 cases used 1 cases contain missing values

Predictor       Coef        Stdev    t-ratio        p
Constant      17.454        2.816       6.20    0.000
ave79x       0.09881      0.05736       1.72    0.088

s = 20.84        R-sq = 3.0%        R-sq(adj) = 2.0%

Analysis of Variance

SOURCE        DF          SS          MS         F        p
Regression     1      1288.7      1288.7      2.97    0.088
Error         97     42130.2       434.3
Total         98     43418.9

Unusual Observations
Obs.    ave79x     ave79y        Fit   Stdev.Fit    Residual     St.Resid
  3         8     106.00      18.24        2.53       87.76       4.24R
  6       146      24.00      31.88        6.82       -7.88      -0.40 X
  9       143      27.00      31.58        6.66       -4.58      -0.23 X
 16       142      24.00      31.48        6.60       -7.48      -0.38 X
 48        45      82.00      21.90        2.21       60.10       2.90R
 64        17      99.00      19.13        2.28       79.87       3.86R
 77        -3     -77.00      17.16        2.93      -94.16      -4.56R
 97       119      30.00      29.25        5.39        0.75       0.04 X
 98       145      46.00      31.77        6.76       14.23       0.72 X
100        73      69.00      24.66        3.11       44.34       2.15R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >
MTB > note o1-o3 sub-pop
```

```
MTB >
MTB > regr c7 1 c8

The regression equation is
ave13y = 18.6 + 0.0681 ave13x

99 cases used 1 cases contain missing values

Predictor       Coef        Stdev    t-ratio        p
Constant      18.571        2.722       6.82    0.000
ave13x       0.06814      0.05512       1.24    0.219

s = 20.99        R-sq = 1.6%        R-sq(adj) = 0.5%

Analysis of Variance

SOURCE        DF          SS          MS         F        p
Regression     1       673.4       673.4      1.53    0.219
Error         97     42745.6       440.7
Total         98     43418.9

Unusual Observations
Obs.    ave13x      ave13y         Fit  Stdev.Fit    Residual    St.Resid
  3        -2      106.00       18.44       2.79       87.56      4.21R
  9       191       27.00       31.59       9.06       -4.59     -0.24 X
 48        97       82.00       25.18       4.20       56.82      2.76R
 64         0       99.00       18.57       2.72       80.43      3.86R
 77        -8      -77.00       18.03       3.02      -95.03     -4.57R
100        35       69.00       20.94       2.12       48.06      2.30R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >
MTB > note o4-o5 sub-pop
MTB >
MTB > regr c9 1 c10

The regression equation is
ave45y = 18.6 + 0.0511 ave45x

99 cases used 1 cases contain missing values

Predictor       Coef        Stdev    t-ratio        p
Constant      18.573        2.544       7.30    0.000
ave45x       0.05108      0.03444       1.48    0.141

s = 20.92        R-sq = 2.2%        R-sq(adj) = 1.2%

Analysis of Variance

SOURCE        DF          SS          MS         F        p
Regression     1       962.9       962.9      2.20    0.141
Error         97     42456.0       437.7
Total         98     43418.9

Unusual Observations
Obs.    ave45x      ave45y         Fit  Stdev.Fit    Residual    St.Resid
  3        18      106.00       19.49       2.25       86.51      4.16R
  6       242       24.00       30.93       7.22       -6.93     -0.35 X
```

```
 23      185      27.00      28.02      5.37      -1.02      -0.05 X
 48       66      82.00      21.94      2.26      60.06       2.89R
 49      375      43.00      37.73     11.67       5.27       0.30 X
 64       45      99.00      20.87      2.11      78.13       3.75R
 77       -8     -77.00      18.16      2.71     -95.16      -4.59R
100       49      69.00      21.05      2.12      47.95       2.30R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >
```

```
Worksheet size: 3500 cells

MTB > Retrieve  'A:\ADVMOD.MTW'.
Retrieving worksheet from file: A:\ADVMOD.MTW
Worksheet was saved on 10/ 8/1996
MTB > Save  'A:\ADVMOD.MTW';
SUBC>    Replace.
Saving worksheet in file: A:\ADVMOD.MTW
* NOTE  * Existing file replaced.
MTB >
MTB > NOTE THIS SESSION USES THE ADVANCED MODEL WITH Y = DEL90
MTB > NOTE VERSUS BAQ90, VHA90, AND %POP FOR 25 CITIES INCLUDING
MTB > NOTE HAWAII
MTB >
MTB > REGR C1 3 C2 C3 C4

The regression equation is
hud = 51.0 - 0.136 baq14 + 0.106 vha14 - 29.6 %pop

124 cases used 1 cases contain missing values

Predictor       Coef      Stdev    t-ratio       p
Constant       50.99      34.83       1.46   0.146
baq14        -0.1362     0.1116      -1.22   0.225
vha14        0.10589    0.01673       6.33   0.000
%pop          -29.60      13.34      -2.22   0.028

s = 23.45       R-sq = 26.8%     R-sq(adj) = 24.9%

Analysis of Variance

SOURCE       DF          SS          MS        F       p
Regression    3    24098.7      8032.9    14.61   0.000
Error       120    65963.9       549.7
Total       123    90062.6

SOURCE       DF       SEQ SS
baq14         1        168.3
vha14         1      21223.4
%pop          1       2707.0

Unusual Observations
Obs.    baq14         hud        Fit   Stdev.Fit   Residual   St.Resid
  3      281      106.00      24.04        4.48      81.96      3.56R
 48      303       82.00      23.32        2.71      58.68      2.52R
 64      316       99.00      38.15        3.61      60.85      2.63R
 77      327      -77.00      11.19        3.60     -88.19     -3.81R
105      335      138.00      38.54        4.55      99.46      4.32R
109      335      -30.00      25.56        3.44     -55.56     -2.40R
125      335      149.00      56.36        6.75      92.64      4.13R

R denotes an obs. with a large st. resid.

MTB > NOTE ABOVE ANALYSIS WAS ON E1-E4 GROUP
MTB > NOTE DROPPING BAQ VARIABLE
MTB >
MTB > REGR C1 2 C3 C4

The regression equation is
hud = 8.72 + 0.104 vha14 - 29.1 %pop
```

124 cases used 1 cases contain missing values

Predictor	Coef	Stdev	t-ratio	p
Constant	8.723	3.649	2.39	0.018
vha14	0.10387	0.01668	6.23	0.000
%pop	-29.13	13.36	-2.18	0.031

s = 23.49 R-sq = 25.8% R-sq(adj) = 24.6%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	2	23280	11640	21.09	0.000
Error	121	66782	552		
Total	123	90063			

SOURCE	DF	SEQ SS
vha14	1	20656
%pop	1	2624

Unusual Observations

Obs.	vha14	hud	Fit	Stdev.Fit	Residual	St.Resid
3	107	106.00	19.81	2.84	86.19	3.70R
48	138	82.00	22.04	2.50	59.96	2.57R
64	322	99.00	38.28	3.62	60.72	2.62R
69	353	0.00	30.04	6.45	-30.04	-1.33 X
77	48	-77.00	13.40	3.12	-90.40	-3.88R
93	347	0.00	29.43	6.40	-29.43	-1.30 X
97	386	2.00	48.10	4.83	-46.10	-2.01R
103	58	-35.00	13.72	2.87	-48.72	-2.09R
105	313	138.00	41.19	4.00	96.81	4.18R
109	216	-30.00	28.45	2.49	-58.45	-2.50R
112	306	-10.00	36.61	3.40	-46.61	-2.01R
117	347	*	29.43	6.40	*	* X
125	514	149.00	58.66	6.50	90.34	4.00RX

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

```
MTB >
MTB > NOTE E5-E6 GROUP
MTB >
MTB > REGR C5 3 C6 C7 C8
```

The regression equation is
hud2 = 49.5 - 0.103 baq56 + 0.0915 vha56 - 29.7 %pop2

124 cases used 1 cases contain missing values

Predictor	Coef	Stdev	t-ratio	p
Constant	49.49	34.67	1.43	0.156
baq56	-0.10286	0.08467	-1.21	0.227
vha56	0.09154	0.01437	6.37	0.000
%pop2	-29.68	13.31	-2.23	0.028

s = 23.41 R-sq = 27.0% R-sq(adj) = 25.2%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	3	24320.9	8107.0	14.80	0.000
Error	120	65741.7	547.8		
Total	123	90062.6			

SOURCE	DF	SEQ SS
baq56	1	168.5
vha56	1	21430.5
%pop2	1	2721.9

Unusual Observations

Obs.	baq56	hud2	Fit	Stdev.Fit	Residual	St.Resid
3	368	106.00	26.10	4.47	79.90	3.48R
48	397	82.00	24.38	2.71	57.62	2.48R
64	414	99.00	38.30	3.61	60.70	2.62R
77	429	-77.00	11.13	3.60	-88.13	-3.81R
105	439	138.00	40.71	4.74	97.29	4.24R
109	439	-30.00	27.39	3.52	-57.39	-2.48R
125	439	149.00	54.76	6.49	94.24	4.19R

R denotes an obs. with a large st. resid.

```
MTB > NOTE DROPPING BAQ VARIABLE
MTB >
MTB > REGR C5 2 C7 C8
```

The regression equation is
hud2 = 7.62 + 0.0898 vha56 - 29.2 %pop2

124 cases used 1 cases contain missing values

Predictor	Coef	Stdev	t-ratio	p
Constant	7.619	3.750	2.03	0.044
vha56	0.08984	0.01433	6.27	0.000
%pop2	-29.21	13.34	-2.19	0.030

s = 23.45 R-sq = 26.1% R-sq(adj) = 24.9%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	2	23512	11756	21.37	0.000
Error	121	66550	550		
Total	123	90063			

SOURCE	DF	SEQ SS
vha56	1	20873
%pop2	1	2640

Unusual Observations

Obs.	vha56	hud2	Fit	Stdev.Fit	Residual	St.Resid
3	159	106.00	21.85	2.78	84.15	3.61R
48	184	82.00	23.09	2.50	58.91	2.53R
64	387	99.00	38.44	3.62	60.56	2.61R
77	67	-77.00	13.33	3.11	-90.33	-3.89R
103	81	-35.00	13.88	2.85	-48.88	-2.10R
105	398	138.00	43.31	4.23	94.69	4.10R
109	282	-30.00	30.23	2.63	-60.23	-2.58R
112	380	-10.00	37.81	3.54	-47.81	-2.06R
125	589	149.00	57.09	6.22	91.91	4.06R

R denotes an obs. with a large st. resid.

```
MTB >
MTB > NOTE E7-E9 GROUP
MTB >
MTB > REGR C9 3 C10 C11 C12

The regression equation is
hud3 = 63.2 - 0.112 baq79 + 0.0804 vha79 - 29.5 %pop3

124 cases used 1 cases contain missing values

Predictor       Coef        Stdev    t-ratio       p
Constant       63.24        34.79       1.82   0.072
baq79       -0.11162      0.06926      -1.61   0.110
vha79        0.08040      0.01248       6.44   0.000
%pop3         -29.46        13.28      -2.22   0.028

s = 23.34       R-sq = 27.4%     R-sq(adj) = 25.6%

Analysis of Variance

SOURCE        DF          SS          MS         F       p
Regression     3     24677.8      8225.9     15.10   0.000
Error        120     65384.9       544.9
Total        123     90062.6

SOURCE        DF       SEQ SS
baq79          1        167.7
vha79          1      21827.6
%pop3          1       2682.4

Unusual Observations
Obs.    baq79       hud3        Fit  Stdev.Fit   Residual     St.Resid
  3       454     106.00      25.27       4.45      80.73       3.52R
 48       490      82.00      24.05       2.70      57.95       2.50R
 64       510      99.00      38.16       3.56      60.84       2.64R
 77       529     -77.00      10.15       3.65     -87.15      -3.78R
105       541     138.00      40.33       4.68      97.67       4.27R
109       541     -30.00      28.31       3.56     -58.31      -2.53R
125       541     149.00      56.35       6.66      92.65       4.14R

R denotes an obs. with a large st. resid.

MTB > NOTE DROPPING BAQ VARIABLE
MTB >
MTB > REGR C9 2 C11 C12

The regression equation is
hud3 = 7.50 + 0.0772 vha79 - 28.8 %pop3

124 cases used 1 cases contain missing values

Predictor       Coef        Stdev    t-ratio       p
Constant       7.502        3.779       1.99   0.049
vha79        0.07721      0.01241       6.22   0.000
%pop3         -28.78        13.36      -2.15   0.033

s = 23.50       R-sq = 25.8%     R-sq(adj) = 24.6%
```

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	2	23263	11631	21.07	0.000
Error	121	66800	552		
Total	123	90063			

SOURCE	DF	SEQ SS
vha79	1	20699
%pop3	1	2563

Unusual Observations

Obs.	vha79	hud3	Fit	Stdev.Fit	Residual	St.Resid
3	159	106.00	19.73	2.84	86.27	3.70R
48	206	82.00	22.35	2.50	59.65	2.55R
64	446	99.00	38.05	3.59	60.95	2.62R
77	78	-77.00	13.24	3.13	-90.24	-3.88R
103	106	-35.00	14.67	2.80	-49.67	-2.13R
105	466	138.00	43.48	4.28	94.52	4.09R
109	350	-30.00	31.89	2.80	-61.89	-2.65R
112	449	-10.00	38.25	3.61	-48.25	-2.08R
117	470	*	28.57	6.34	*	* X
125	708	149.00	58.81	6.52	90.19	4.00RX

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

```
MTB > NOTE O1-O3 GROUP
MTB >
MTB > REGR C13 3 C14 C15 C16
```

The regression equation is
hud4 = 47.8 - 0.0861 baq13 + 0.0723 vha13 - 23.8 %pop4

124 cases used 1 cases contain missing values

Predictor	Coef	Stdev	t-ratio	p
Constant	47.81	35.34	1.35	0.179
baq13	-0.08607	0.07624	-1.13	0.261
vha13	0.07228	0.01229	5.88	0.000
%pop4	-23.80	13.55	-1.76	0.082

s = 23.86 R-sq = 24.2% R-sq(adj) = 22.3%

Analysis of Variance

SOURCE	DF	SS	MS	F	p
Regression	3	21766.8	7255.6	12.75	0.000
Error	120	68295.8	569.1		
Total	123	90062.6			

SOURCE	DF	SEQ SS
baq13	1	170.1
vha13	1	19841.1
%pop4	1	1755.7

Unusual Observations

Obs.	baq13	hud4	Fit	Stdev.Fit	Residual	St.Resid
3	417	106.00	25.57	4.55	80.43	3.43R

48	450	82.00	22.07	2.76	59.93	2.53R
64	469	99.00	35.58	3.46	63.42	2.69R
77	486	-77.00	11.21	3.71	-88.21	-3.74R
105	497	138.00	32.05	4.15	105.95	4.51R
109	497	-30.00	27.48	3.62	-57.48	-2.44R
125	497	149.00	52.03	6.53	96.97	4.23R

R denotes an obs. with a large st. resid.

```
MTB > NOTE DROPPING BAQ & %POP VARIABLES
MTB >
MTB > REGR C13 1 C15

The regression equation is
hud4 = 4.87 + 0.0713 vha13

124 cases used 1 cases contain missing values

Predictor       Coef      Stdev   t-ratio       p
Constant       4.870      3.389      1.44   0.153
vha13        0.07133    0.01235      5.77   0.000

s = 24.08       R-sq = 21.5%     R-sq(adj) = 20.8%

Analysis of Variance

SOURCE        DF          SS          MS        F       p
Regression     1       19334       19334    33.35   0.000
Error        122       70728         580
Total        123       90063

Unusual Observations
Obs.     vha13        hud4         Fit  Stdev.Fit    Residual    St.Resid
  3       189      106.00       18.37       2.18       87.63       3.65R
 48       191       82.00       18.51       2.18       63.49       2.65R
 64       433       99.00       35.77       3.49       63.23       2.65R
 73       624       40.00       49.35       5.53       -9.35      -0.40 X
 77        76      -77.00       10.27       2.73      -87.27      -3.65R
105       374      138.00       31.52       2.95      106.48       4.46R
109       340      -30.00       29.15       2.69      -59.15      -2.47R
124       664       69.00       52.25       6.00       16.75       0.72 X
125       688      149.00       53.96       6.28       95.04       4.09RX

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB > NOTE O4-O5 GROUP
MTB >
MTB >
MTB > REGR C17 3 C18 C19 C20

The regression equation is
hud5 = 44.9 - 0.0519 baq45 + 0.0556 vha45 - 21.9 %pop5

124 cases used 1 cases contain missing values

Predictor       Coef      Stdev   t-ratio       p
Constant       44.93      36.60      1.23   0.222
baq45       -0.05194    0.05338     -0.97   0.332
vha45        0.05565    0.01118      4.98   0.000
```

```
%pop5          -21.91       14.01      -1.56     0.121

s = 24.65       R-sq = 19.0%     R-sq(adj) = 17.0%

Analysis of Variance

SOURCE       DF          SS          MS         F        p
Regression    3     17131.0      5710.3      9.40    0.000
Error       120     72931.6       607.8
Total       123     90062.6

SOURCE       DF       SEQ SS
baq45         1        170.0
vha45         1      15475.5
%pop5         1       1485.5

Unusual Observations
Obs.    baq45       hud5        Fit  Stdev.Fit   Residual     St.Resid
  3       616     106.00      25.56       4.70      80.44       3.32R
 48       665      82.00      23.25       2.85      58.75       2.40R
 64       693      99.00      30.09       3.06      68.91       2.82R
 77       718     -77.00      10.67       4.04     -87.67      -3.61R
 97       734       2.00      50.13       6.91     -48.13      -2.03R
105       734     138.00      28.72       4.13     109.28       4.50R
109       734     -30.00      28.88       3.94     -58.88      -2.42R
125       734     149.00      41.80       5.73     107.20       4.47R

R denotes an obs. with a large st. resid.

MTB > NOTE DROPPING BAQ & %POP VARIABLES
MTB >
MTB > REGR C17 1 C19

The regression equation is
hud5 = 6.38 + 0.0555 vha45

124 cases used 1 cases contain missing values

Predictor       Coef       Stdev    t-ratio        p
Constant       6.378       3.527       1.81    0.073
vha45        0.05552     0.01120       4.96    0.000

s = 24.79       R-sq = 16.8%     R-sq(adj) = 16.1%

Analysis of Variance

SOURCE       DF          SS          MS         F        p
Regression    1       15106       15106     24.59    0.000
Error       122       74957         614
Total       123       90063

Unusual Observations
Obs.    vha45       hud5        Fit  Stdev.Fit   Residual     St.Resid
  3       228     106.00      19.03       2.23      86.97       3.52R
 48       245      82.00      19.99       2.23      62.01       2.51R
 64       433      99.00      30.43       3.07      68.57       2.79R
 73       861      40.00      54.18       7.25     -14.18      -0.60 X
 77        59     -77.00       9.66       3.04     -86.66      -3.52R
 97       789       2.00      50.17       6.49     -48.17      -2.01RX
105       394     138.00      28.26       2.79     109.74       4.46R
```

```
109         433       -30.00        30.42         3.07       -60.42       -2.46R
125         675       149.00        43.85         5.31       105.15        4.34R

R denotes an obs. with a large st. resid.
X denotes an obs. whose X value gives it large influence.

MTB >
```

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